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Contents.

	PAGE
Forthcoming Events	483
Papers from Abroad	483
Testing and Design	483
I.B.F. Elects New Members	484
Convention Closing Functions	484
Scottish Buchanan Medallist	484
Random Shots	484
International Congress	485
Die Casting	486
Italian Iron and Steel Trade in May	488
The Influence of Chromium in Cast Iron	489
Coal-Dust as Applied to Moulding Sand	493
Trade Talk	498
Contracts Open	498
Personal	498
Obituary	498
Reports and Dividends	498
Iron and Steel Markets	500
Students' Corner	500

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

MAY-OCTOBER.
North-East Coast Exhibition at Newcastle-on-Tyne.

JULY 2-4.
North-East Coast Institution of Engineers and Shipbuilders:—Joint summer meeting with the Institution of Shipbuilders in Scotland, at Newcastle-on-Tyne.

JULY 16-27.
International Aero Exhibition at Olympia, London, W.

Papers from Abroad.

At this year's Convention it was noteworthy that there was a record number of foreign exchange Papers, and that, in fact, they exceeded the total number of Papers presented to last year's Convention at Leicester. This fact makes pertinent some consideration of the value and the position of these Papers. Originally, of course, they were intended to promote international contacts between the founders of the world, and to facilitate the exchange of ideas and experience among them. That this is well on the way to achievement is clearly shown by the increasing number of contributors and contributing countries. This year's Papers, for example, include among the contributors Holland, Poland and Czecho-Slovakia, as well as U.S.A., Germany, France and Belgium. At the same time, it must be remembered that quantity and quality are not necessarily synonymous, and a mere growth in the volume and number of exchange Papers is not in itself proof of their increasing value. Assuming that the primary object of the exchange Paper, namely, to foster international interchange in the foundry world, has now to some extent been secured, what is the desirable direction for the future development of this very valuable instrument?

In the first place, of course, the good work must be carried on. It is of little use to establish these contacts if they are not to be kept actively alive and significant, and from this point of view the larger the number of contributing countries the better. But, in the second place, the object of the exchange Paper should surely be to present to the organisation in the receiving country work which is not in general available to its members, either on account of the language in which it is written or of the obscurity of the material. And it is a matter of some doubt how far this object is always borne in mind. There would seem, for instance, to take a very obvious example, very little value in the presentation to a Czecho-Slovakian Convention of matter already available in Germany, since German is currently spoken in Czecho-Slovakia, and the original work is therefore easily accessible. The exchange Paper, therefore, should surely consist either of original work—although the prior claim of the worker's own country to receive such work must be carefully considered—or else something in the nature of an authoritative review of work already done and results already published at home. By original work we have in mind no narrow limitation to work of an academic or theoretical character. The Papers might with interest and profit cover anything in the whole range of foundry practice or theory, but they should, in our opinion, aim at providing a definite contribution to the sum of technical knowledge possessed by the audience for whom they are intended.

Testing and Design.

There was an exceedingly interesting and enlightened discussion on the subject of the testing of castings at the International Foundrymen's Congress, but we were convinced that sight was lost of the basic conditions underlying the subject. Primarily, the object is to help the designer to have complete confidence in the structures or machines he has under consideration. We suggest that it is illuminating for the foundry experts to visit the drawing office—the birthplace of their handiwork—and ascertain first hand the *modus operandi* in vogue. They will find that all calculations are based on the tensile strength of cast iron, which is assumed to be either of eight or ten tons per square inch. Then this figure is probably divided by a factor of safety of five, so that something like two tons per square inch is the maximum strain to be taken care of.

The average designer possesses a very definite mental conception of just what is expressed by tensile stress, and any other factor submitted is translated by him into a tensile equivalent. Before one leaves the drawing office, one cannot help but feel that any change envisaged can only be materialised either by reorganising the standard training of the designer so that he never over-appreciates tensile values or devise a test that is readily and accurately convertible into the figures which he has so long utilised and mentally evaluated. The designer is aware that the testing machine will very rarely give a higher figure than the truth; in fact, the contrary is more general. He also apparently is cognisant of the "fact" that cast iron breaks along the graphite flakes, as these constitute planes of weakness. In this connection, we had recently brought to our notice a curious experiment which did not support this "fact." A microphotograph of cast iron at 50 diameters showed well-defined graphite plates. Each plate was slit by a sharp knife, and the paper, which would be somewhat stronger than cast iron, say 20 tons per square inch, was submitted to tensile testing conditions. The fracture did *not* travel via the slits. We outline this with the object of receiving confirmation or denial as to whether the mechanism of fracture from tensile stress is more to be associated with looseness of texture rather than planes of weakness.

Finally, we see little hope in our time of convincing the designer that he should provide himself with new vistas when concretising the nebulous.

XUM

I.B.F. Elects New Members.

At a Council meeting, which preceded the annual meeting of the Institute of British Foundrymen, held in London, the following gentlemen were elected to its various grades of membership:—

As Members.

A. J. Arnold, "Sandy Mount," quarry owner, Leighton Buzzard, Beds; D. Hanson, D.Sc., Professor of Metallurgy, the University of Birmingham; S. Hashimoto, chief foundry engineer, Tama Shipbuilding Yard, Mitsui & Company; F. J. Hemming, joint managing director, F. H. Lloyd & Company, Wednesbury; A. E. Mellerup, works director, R. A. Lister & Company, Dursley; A. E. Prince, foundry foreman, Perry Bar Metal Company, Perry Bar, Birmingham; G. Shaw, M.A., steel founder, Wellington Foundry, Middlesbrough; W. G. Shaw, B.A., steel founder, Wellington Foundry, Middlesbrough; C. W. Smith, foundry foreman, R. A. Lister & Company, Dursley; J. E. Whitehead, director, Whitehead & Poole, Limited, Radcliffe, Lancs; L. Whitehouse, foundry manager, Oak Foundry, Limited, Bournbrook; C. Wood, chief metallurgist, Beecroft & Partners, Limited, Sheffield; and A. Lawrie, foundry manager, A. Strang & Company, Hurlford, Kilmarnock.

As Associate Members.

J. Carter, metallurgist, Blackstone & Company, Stamford, Lincs; J. F. Davies, foundry manager, W. A. Baker & Company, Newport, Mon; H. Edy, moulder, Tubal Cain Foundry, Cardiff; O. N. France, foreman moulder; G. S. Gentle, foreman patternmaker, Aston Construction Company, London, N.1; A. Haines, foundry manager, British Thomson-Houston Company, Limited, Rugby; E. J. E. Jenkins, moulder, Belliss & Morcom, Limited, Birmingham; W. R. D. Jones, lecturer in metallurgy, University, Cardiff; T. R. Langby, foundry foreman, Lake & Elliott, Limited, Braintree, Essex; G. E. Morgan, iron moulder, East India Railway, Jamalpur; J. Mackintosh, patternmaker, Falkirk Iron Company; A. Nicol, moulder, Forth & Clyde & Sunnyside Iron Company; W. Siddle, chemist, British Chilled Roll and Engineering Company, Limited, Haverton Hill; A. Slater, foreman moulder, W. Knott & Son, Manchester; J. Thomas, foundry engineer, Richardson, Westgarth & Company, Limited, Hartlepool; and N. C. Blythe, brass moulder, G. & J. Weir, Limited, Glasgow.

As Associate.

G. Biggin, moulder, Laycock Engineering Company, Limited, Sheffield.

Convention Closing Functions.

On Thursday evening, June 13, nearly 500 delegates and ladies accepted the joint invitation of the London Branch of the Institute of British Foundrymen and the Foundry Trades' Equipment and Supplies Association to a Dance and Cabaret at the New Burlington Galleries. The guests were received by Mr. W. B. Lake, President of the London Branch of the Institute of British Foundrymen, and Mrs. Lake, and by Mr. H. Winterton, President of the Foundry Trades Equipment and Supplies Association, and Mrs. Winterton. A cabaret entertainment was provided by "The Marshmallow Girls" under the direction of Mr. Gordon Marsh, and other artistes included Miss Olive Tyson and Miss Mollie Seymour. The orchestra was under the direction of Mr. Ernest Rutterford. A very enjoyable evening was concluded at midnight by the singing of "Auld Lang Syne."

The next day, Friday, June 14, was the last day of the official Conference arrangements and was devoted to a whole day excursion through the county of Kent to Canterbury. Nearly 200 delegates and ladies, including a large number of overseas visitors took part. A halt for luncheon was made on the outward journey at the "Tudor House," Bearsted; the party then proceeded to Canterbury, where they were conducted around the Cathedral. On the return journey tea was provided at the "Tudor House" and the party then returned to London.

A very interesting informal ceremony took place in the lounge of the Hotel Cecil upon the return from the excursion to Canterbury, when Mrs. S. T. Johnston, wife of the President of the American Foundrymen's Association, presented a shawl to Mrs. Wesley Lambert, wife of the President of the Institute of British Foundrymen. The presentation was made on behalf of the ladies of the American party as a memento of the tour of Great Britain, on which they were accompanied by Mr. and Mrs. Lambert, and also of their visit to the London Congress.

Scottish Buchanan Medallist.

Mr. Norman C. Blythe, who was awarded a Buchanan medal at the annual conference in London, was born in Glasgow on December 9, 1907. He received his education at Victoria

Mr. Norman C. Blythe.

Drive Higher Grade School, Glasgow, and later at the Royal Technical College, Glasgow. He chose foundry work as a career, and served his apprenticeship in the foundry of Messrs. Mavor & Coulson, Limited, engineers, Mile End, Glasgow. He supplemented his foundry training by serving in various engineering departments for about a year. Mr. Blythe tied for second place in the John Surtees Medal competition in 1926, and he was awarded a gold medal for the best fifth-year apprentice at Mavor & Coulson's in 1927. Later Mr. Blythe was transferred to the staff at Mile End and employed in various capacities, chiefly in making investigations in connection with administrative work. Mr. Blythe has recently left Messrs. Mavor & Coulson to gain further foundry experience, and is now employed with Messrs. G. & J. Weir, Limited, Holm Foundry, Cathcart. He has been secretary of the Scottish Junior Branch, I.B.F., since its inauguration in 1927.

American Machinery Exports in 1928.—The value of exports of metalworking machinery from the United States during 1928 totalled $34,125,000, exceeding those for 1927 by $7,746,000, and breaking all records since the abnormal post-war year of 1920.

Random Shots.

An extra attraction at the cabaret held during the London Convention was the suitably exotic background provided by the paintings of Señor Beltran-Masses, which were on show at the time. Those of us who spared a minute or two from the delights of the programme and the joys of meeting our business friends on a non-business basis were subsequently amused at the attention paid to these paintings by the daily Press. Much comment was aroused by the "hypnotic eyes" of the ladies on the canvases, while discussion raged fast and furious as to the quality of the colour effects, the suitability of the titles, and the choice of subject. All things considered, the show appears to have been something in the nature of an advertisement for the manufacturers of cosmetics for our lady friends.

* * *

A very different background was provided by the Guildhall, and it was a background that could not fail to remind us of the honourable antiquity of our industry. Ironfounding can lay claim to being one of the early crafts, between whose guilds or trade organisations (if I may be pardoned the anachronistic expression) and the Guildhall there was more than a little connection. My knowledge on this subject is somewhat rusty, and the question is an intricate one, but I feel that, in view of recent events, I might with advantage to myself and my readers refresh my memory.

* * *

Minor points in connection with the Convention that come to my mind are:—The special significance of the royal toast at a time like this—a significance which our foreign visitors were quick to appreciate; the desirability, when speaking in a large hall, of speaking into the microphone provided for the purpose; the quality of the singing provided as entertainment; and last, but not least, the attention paid to the Convention in the Press and the success it undoubtedly achieved with all concerned. There is no doubt that the foundry trade and its organisations are rising in prestige. As one visitor pointed out after the Guildhall reception, there will soon be no further heights to which we can aspire, short of Windsor Castle!

* * *

Founders can hardly fail to be interested in the recent appointment of Mr. Arthur Henderson as Foreign Secretary. He began his working life as a moulder, and of recent years he has frequently attended meetings of the Institute of British Foundrymen, and he displayed his interest in his old trade by being closely identified with the last London Convention. Mr. Longden, the new M.P. for one of the Birmingham divisions, is also closely identified with the industry. Can any readers tell us of further recruits to the political ranks who have a connection with founding, other than the gentlemen mentioned elsewhere in a recent issue? It would be interesting to know of them. In this connection we must mention the loss sustained by the industry in the reverse suffered by Mr. Cyril Lloyd at Dudley.

* * *

And in this connection, too, there was once a political speaker who suffered from excessive corpulence, and who was told by an exasperated listener to "Go to hell." "Then," replied the stout gentleman, with ready wit and imperturbable good humour, "the fat would be in the fire, wouldn't it?"

Marksman.

International Congress.

List of Delegates Present.

Great Britain.

J. Affleck (Glasgow), E. Ainsworth (London), F. Allan (Sunderland), A. E. Allen (Birmingham), T. F. Allen (Birmingham), J. B. Allan (Sheffield), G. L. Anderson (Edinburgh), A. J. Arnold (London), Major J. W. Athey (Birmingham).

W. R. Bates (Wellingborough), A. F. Barnaby (Frodingham), J. Bayne (Rainhill, Lancs), E. Bean (Hull), H. J. Beck (Normanton), Dr. M. L. Becker (Teddington), Robert P. Bethell (Walsall), A. M. Bennett (Leeds), A. S. Beech (London), J. Bell (Whitley Bay), J. Bell (Glasgow), J. Bevins (Ulverston), C. W. Bigg (Allestree, near Derby), J. S. Birchall (Rochdale), E. M. Boote (Coventry), K. J. J. Bone (Luton), A. W. G. Bagshawe (Dunstable), G. Buchanan (Bradley, Staffs), F. G. Butters (Ilkeston), C. Blades (Syston), John P. Brand (Kingston-on-Thames), J. Burrell (Willington Quay), A. R. Bartlett (Belvedere, Kent).

A. Campion (Glasgow), H. D. Campbell (Glasgow), G. C. Castle (Sheffield), E. A. Carlisle (Sheffield), A. Carr (Chadwell Heath, Essex), J. Cameron, Past-President (Lenzie, N.B.), J. F. Chambers (Windsor), E. A. Chell (London), F. J. Cook, Past-President (Birmingham), F. D. Corbin (Llanelly), C. W. Coleman (London), H. F. Coggan (Halifax), J. H. Cooper (Darlington), J. J. Collin (Sunderland), H. Cowan (Glasgow), F. J. Cree (Peterborough), Capt. R. Crewdson (London), J. Currie (Bathgate).

D. Dalrymple (West Bromwich), J. Davenport (Leyland), V. Delport (London), Prof. Cecil H. Desch (Sheffield), H. C. Dews (Sutton, Surrey), Dr. J. W. Donaldson (Greenock), W. E. Dobson (London), W. Donnan (London), J. Durrans (Penistone).

A. Edwards (Cheltenham), J. Ellis, Past-President (London), R. W. E. Etheredge (London), Dr. A. B. Everest (London), J. P. Ellis (London).

V. C. Faulkner, Past-President (London), H. Field (Wolverhampton), A. Firth (Sheffield), B. Fender (Monkseaton), S. W. B. Flavel (Leamington Spa), W. Y. Flavell (West Bromwich), J. E. Fletcher (Dudley), C. Fontaine (Newport, Mon.), G. E. France (Elland, Yorks), A. C. Furmston (Letchworth).

B. Gale (Nottingham), J. W. Gardom (Dunstable), F. Gill (Nottingham), G. F. Gillott (London), J. T. Goodwin, M.B.E., Past-President (Chesterfield), Dr. R. H. Greaves (Southend-on-Sea), C. Gresty (Monkseaton), G. Griffiths (Birmingham), P. Gundry (Cornwall).

A. E. Harford (London), A. Harley, Vice-President (Coventry), F. A. Harper (Stockton-on-Tees), R. R. Hargraves (Manchester), R. C. Hargraves (Stockport), J. Haigh (Harrogate), A. Haines (Rugby), G. Hall (Birkenhead), D. T. Heap (Surrey), J. E. Hearn (Luton), A. Herring (Surrey), C. W. Hampton (Sheffield), G. E. Hider (Torquay), B. Hird (Newport), J. Hird (Birmingham), W. Hird (Bingley, Yorks), H. J. S. Hilton (Derby), A. Hodgson (Manchester), J. Hogg (Burnley), W. A. Homer (Walsall), J. D. Hotchkis (London), L. H. Howell (London), J. R. Hyde (Newcastle, Staffs), E. J. L. Howard (Manchester), J. E. Hurst (Sheffield), R. E. Hoy (Sutton, near Hull), F. Hudson (Kilmarnock).

J. E. Jadoul (Manchester), G. R. Jarmy (Leiston, Suffolk), H. C. Jay (Newcastle), R. S. M. Jeffrey (Kirkintilloch), S. D. Jenkinson (Sheffield), K. S. Jewson (Dereham, Norfolk), C. Jobson (Derby), J. B. Johnson (Tipton, Staffs), W. Jolley (Manchester).

C. Howell Kain (Braintree, Essex), B. B. Kent (Keston, Kent), E. G. King (London), W. S. Kinsman (Cardiff).

J. Laing (Bedford), W. B. Lake (Braintree, Essex), T. R. Langley (Braintree), Wesley Lambert, President (London), H. O. Law (Sheffield), W. Levesley (Sheffield), G. Lillie (Co. Durham), D. C. Lloyd (Wolverhampton), A. Logan (Newcastle-on-Tyne), J. Longden (Clydebank, N.B.), E. Longden (Manchester), C. R. Loxton (Leeds), H. Loxton (Leeds), A. Lomas (Sheffield), G. T. Lunt (Wolverhampton), J. Lucas (Loughborough).

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F. K. Neath (Birmingham), Dr. A. L. Norbury (Birmingham).

E. Oakden (Woodley, Cheshire), G. Offiler (Sheffield), W. O'Keefe (Birmingham), G. L. Oxley (Sheffield), J. Oswald (London).

W. Y. Pateman (Luton), A. E. Peace (Derby), J. G. Pearce, Director B.C.I.R.A., H. Pemberton (Derby), A. E. Perry (London), H. Phillips (Wednesbury), J. Picken (Dawley, Shrops), J. Poole (Manchester), W. H. Poole (Bingley, Yorks), J. S. G. Primrose (Manchester), J. M. Primrose (Falkirk), T. F. Proctor (Glasgow), R. O. Patterson, Past-President, H. S. Primrose (London).

H. Rea (Newport, Mon), J. A. Reynolds (Rainhill, Lancs), J. Riley (Oldham), N. D. Ridsdale (Marton-in-Cleveland), R. Ritchie (Middlesbrough), R. J. Richardson (Pontypridd), W. B. Richardson (Farnworth), A. J. Richman (Ipswich), N. E. Robson (Braintree, Essex), D. Rogers (Llanelly), Dr. Rosenhain (National Physical Laboratory), W. Roxburgh (Rugby), F. Russell (Sheffield), P. A. Russell (Leicester), S. H. Russell, Past-President (Leicester).

F. Sanderson (Newcastle-on-Tyne), F. A. Shirt (Sheffield), J. Shaw (Southsea), W. Sherman (London), R. J. Shaw (Monkseaton), H. Schofield (Manchester), J. N. Simm (Monkseaton), H. Shillitoe (London), A. J. Shore (Birmingham), H. Simpson (Dawley, Shrops), J. G. A. Skerl (Sheffield), F. A. Skidmore (Rugby), B. Skidmore (Letchworth, Herts), J. A. Smeeton (London), C. W. Smith (Dursley), H. G. Sommerfield (London, Hon. Congress Secretary), T. A. Spiers (Leicester), E. Stevenson (Carlton, Notts), V. Stobie (Ryton-on-Tyne), W. Street (Loughborough), R. W. Stubbs (Manchester), A. Sutcliffe (Bolton).

W. G. Thornton (Bradford), L. J. Tichelly (London), C. D. Townsend (Brigg, Lincs), A. C. Turner (London), Professor Thomas Turner (Leatherhead, Surrey), T. Henry Turner (Birmingham), E. H. Tyson (Birmingham).

C. R. Van-der-Ben (Gateshead-on-Tyne).

R. C. Waddell (Glasgow), A. Walker (Rugby), T. R. Walker (Sheffield), J. Wasteney (Eckington, Sheffield), Francis J. Wares (Peterborough), R. Watson (Rugby), J. F. Webster (Arbroath), W. West (Leyland), J. Wharton (Maryport), A. O. White (Wednesbury), J. E. Whysall (Nottingham), T. Wilkinson (Stockton-on-Tees), R. G. Williams (Barry, Glam), S. V. Williams (Kenton), F. P. Wilson (Vice-President), R. Wilson (Wednesbury), W. R. Wilson (Liverpool), W. Williams (Cardiff), N. S. F. Winter (Halifax), H. Winterton (President, Foundry Trades Equipment Association), C. H. V. Wilson (London), C. Wood (Sheffield), G. R. Webster (Birmingham), B. Winterton (Sheffield), Commander E. C. Withers (London), A. C. Worcester (Huddersfield), D. H. Wood (Birmingham), S. Wyborn (Sherwood, Notts), R. Yates (Accrington), H. J. Young (London).

Australia.

R. Mason, Adelaide (representing Government of South Australia).

Poland.

H. S. A. Branson, J. Buzek, K. Gierdziejewski, J. Komorowski, W. Loskiewicz, O. Marcinowski, M. Skalski.

America.

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Denmark.

A. Hess.

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A. Brizon, Mr. Gailly, H. Magdelanat, E. Ramas (Hon. President, French Foundry Association), F. Renaud, E. Ronceray (Vice-President, French Foundry Association), Mr. Viez.

Germany.

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Luxemburg.

L. Brasseur.

Czecho-Slovakia.

P. Bacher, A. Plesinger.

Spain.

Maas Baga.

Die Casting.*

By A. H. Mundey (Member).

The art of die casting is of the greatest interest to the foundryman, yet it is feared that this interest is not wholehearted as a general rule. The attitude is apt to be one of good-humoured tolerance, not unmixed with a trace of contempt. It is easy to understand this, for the foundryman's craft is essentially that of the moulder in sand and loam, and any process which aims at the displacement of this highly-skilled craft must of necessity be viewed with suspicion, even if this displacement be only in respect of a minute fraction of the total output of the foundry man.

It has been pointed out several times recently that when an intelligent person, who has no intimate knowledge of the work, visits a foundry and sees the large and beautifully-prepared moulds ready for a casting—moulds, so costly in money as well as skilled effort and time—and the visitor learns that the mould is used but once, that it is destroyed in giving birth to one casting only, the natural question arises, cannot moulds of a permanent or at least a more-lasting character be employed? Die-casting, in a limited measure and in respect to small castings which are required in large numbers, is the attempt to furnish a practical answer.

Die casting has been studied during recent years by a number of metallurgists, both from the point of view of scientific research and as a technical problem of industry. Many Papers have been read and lectures given and discussed. The author has had some small share in these efforts to obtain and disperse reliable information. It will, therefore, be impossible to present to the Institute details which are entirely new and unpublished, as the investigators have honestly reported results of experimental and explorative work, whether successful or not, to the great advantage of all engaged in the industry.

Die casting may be defined as a method of production of castings in a highly-finished or semi-finished condition, accurate to form and dimensions, with holes and inserts as required, screwed parts, both internal and external complete, by pouring or by forcing under pressure, molten metal into well-finished permanent or long-life moulds. These moulds are frequently called dies; this is probably on account of the fact that they are produced by highly-skilled tool-fitters and die-sinkers and not by the moulder, as in general foundry practice.

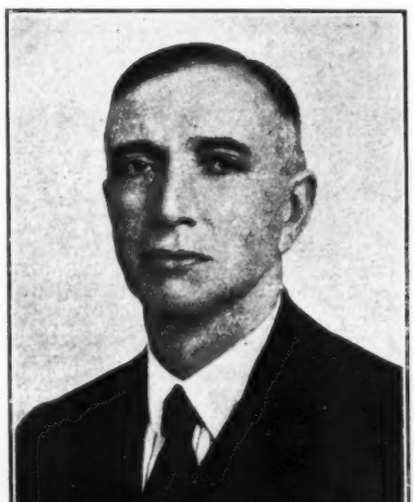
The process is distinguished from that usually known as chill casting, in that the latter usually requires a subsequent machining operation, or even forging and machining before the article is ready for use, on the other hand, die-castings are very largely polished and plated after casting and trimming.

Die casting is not a newly-invented process, for the ancient armourers used more or less permanent moulds of stone or burnt clay for the production of spearheads, axes and other weapons, these castings being of bronze. The method of production, by simply pouring molten metal into the mould, is now usually called "gravity" die casting, as distinguished from the employment of pressure, either by a pump-plunger or high-pressure air when it is designated "pressure" die casting, thus excluding the term chill casting altogether.

Type casting is the oldest-established branch of die casting, and it is probable that the printing industry employs an amount of die castings in the form of type and stereo-plates, which far exceeds in weight the whole output for all other trades.

The early dies were simple, consisting of three members, two forming the mould for the body of the type, and the other the matrix for the type face, the metal being poured from a small ladle, whilst the mould was held in the hand. Type-casting machines are excellent examples of automatic die casting. Here, in a belt or single-unit motor-driven machine, molten metal is pumped into a three-part mould, which is carried to a nozzle to receive it, the mould is opened, the casting ejected, the tang removed, the cycle of operations is now repeated, each movement being effected by appropriate cam-mechanism. The composing machines, of which the Linotype and the Monotype are the most notable examples, are developments of the type casters.

A few specimens of the products of these machines will be of interest to foundrymen, whose usual work is of such different character, one specimen only will be specially mentioned. A Monotype type, one-sixth of an inch-square section, on this small surface the whole of the Lord's Prayer is cast, the definition being perfect, as viewed under a low-power microscope.



MR. A. H. MUNDEY.

At the other end of the scale of castings for printers there is the stereotype foundry. In the office of one great London daily newspaper no less than 40 tons of metal is cast into plates (all of which are of outstanding merit as to workmanship) nightly. Bullet casting was probably the next operation in which die casting was employing in an extensive way.

Anderson and Boyd, in an American Exchange Paper to this Institute (Vol. XVII, 1923-24), gave an excellent classification, and Capt. George Mortimer adopted this in his Paper to the Institute of Metals in 1926; it was as follows:—(A) Slush casting; (B) gravity casting; (C) centrifugal casting; (D) corthias casting; and (E) pressure casting. Cartland, in a lecture to the Coventry Engineering Society, 1928, expanded this, as set out in Table I.

Die casting can be classified into two main divisions, *i.e.*, pressure die casting and gravity die casting, but before passing on to discuss these in detail it is proposed briefly to describe the three other processes.

Slush Casting.

The first is slush casting, which is used for the production of articles of decorative rather than engineering value, such as toy soldiers, statuettes and chandelier fittings. The metal is poured into the mould, and the mould is then almost immediately inverted and the majority of the metal poured out again, but a thin lining solidifies against the cool surface of the mould, thus producing a light hollow casting without any elaborate method of "coring."

TABLE I.—*Classification of Die Castings.*

Slush		Tin base	
Centrifugal		Tin-antimony	
Corthias	Plunger	Lead base	
Pressure	Plunger	Zinc Base	Tin, copper, hardened
			Copper, aluminium hardened
	Air	All above	
		Aluminium Alloys	
Gravity	All above		
	Aluminium alloys		
	Aluminium bronze		
	Cast iron		

Centrifugal Casting.

This is a method by which centrifugal force is employed to bring pressure to aid in the filling of the mould. Its application is very limited indeed, but castings of very close, even grain can be produced.

Corthias Casting.

A measured amount of metal is poured into the mould and a tightly-fitting core attached to a plunger is then immediately forced into the mould with pressure. This gives the effect of pressure die casting, but the process is naturally limited to the comparatively few designs in which the pressure can be applied by the insertion of the core.

Pressure Die Casting.

This is one of the two main divisions of the die-casting industry, and by pressure methods castings can be produced with a high degree of finish, a remarkable dimensional accuracy, and with holes correctly spaced, true to size, with internal and external screw threads, with bushes and inserts placed as required and cast at a great speed, when once the dies have been correctly designed, made and tested.

The apparatus used is simple in principle. Imagine a melting-pot formed essentially like a teapot; the vessel is filled, or nearly so, with molten metal, the lid is replaced by a plunger, the mould or die is attached firmly to the spout; a sharp application of pressure to the plunger forces a supply of molten metal up the spout and into the die, which is so arranged as to be capable of ready opening for the release of the casting. A small hand-operated machine, patented in 1872, worked exactly on these lines, and, although modern machines of the plunger type have become relatively complicated in design, the same general principle applies.

The general equipment for die casting by this method usually includes several melting-pots, normally of cast iron, and gas- or oil-heated, placed handily for supplying molten metal to the actual casting-machine, which has a reservoir containing metal, kept hot by gas-burners, enclosed in a chamber lined with firebrick.

The pump with plunger is attached to the reservoir and the plunger is operated by means of a long lever. The mould or die is fastened to a swinging or hinged plate and is brought into communication with the spout by swinging the plate into position and fastening with clips The mould, being in two parts at least, is held together by means of a toggle-joint which admits of quick release, thus parting the mould. The parts of the mould are kept in register by means of dowels. Holes in the casting are formed by means of cores which are removed by rack-and-screw mechanism. Internal threads are formed by means of screw cores and external ones by screwed collars. The air is displaced by the incoming metal through vents which are placed at

* A Paper presented to the International Foundrymen's Congress.

suitable positions—the success of any particular casting often depends largely on skilful venting of the die. The vents themselves are frequently very thin, flat apertures through which air can pass, but on account of their small sectional area the metal is unable to follow.

Dies are generally of steel—the main portions of mild steel, the special parts of alloy steel, such as nickel chrome, whilst as much of the body of the die as can be, is made of cast iron. The choice of material is controlled by the class of alloy to be used and the character of the casting.

The operation of casting in a plunger type of machine is as follows:—The reservoir is filled with molten metal and the lip of the nozzle cleaned from dross and partly-solidified metal. The die is opened, cleaned, oiled, and, in some cases, dusted with French chalk, cores are racked and screwed into position, and inserts or bushes placed in position. The die is then closed and by means of the plate, on which it is fastened, is brought with the aperture pressed close against the nozzle of the metal reservoir. The stroke of the plunger is actuated by a bell-crank lever, the long arm being manipulated by the operator. The kind of pull on the lever is very important; in some cases a sharp stroke is necessary, whilst in others a steady, strong follow-through is required. The workmen become remarkably skilful in maintaining the kind of pull to give the best result as well as in general management of the whole machine. The dies and cores are generally water-cooled; the adjustment of the rate-of-circulation to maintain the best die-temperature is important.

After completion of the casting, the spout is severed and removed and the mould opened, a set of ejector-pins which lie flush with the surface of the die is operated and the casting gently pushed out immediately after solidification. The marks of these ejector-pins are just visible on practically all zinc-base die castings. The die is now ready for a further cycle of operations. The casting is given a preliminary inspection and then passed on for trimming, polishing, plating, etc., if required, before final inspection.

The plunger-type of pressure die casting already described is suitable for all alloys of low melting-point, that is, up to about 450 deg. C., and under this heading are:—

(1) *All tin-base alloys* for bearings of every description. This section of the die-casting industry is one which is almost complete in itself; castings can be produced with great precision and excellent finish. The subject of die-cast automobile-bearings is one which will probably be well known to the members of this conference.

(2) *Special tin-antimony alloys*, which are used for gas-meter parts. These also produce castings of a high degree of accuracy and finish.

(3) *Antimonial lead alloys* for battery plates, grids, and terminal nuts for batteries, and also for certain weather-resisting window-fittings and other special purposes.

(4) *Zinc-base Alloys.*—This is probably the largest class produced as pressure die castings in the plunger-type machine. Their application covers a vast range of engineering and general commercial work, as will be seen from the specimens exhibited. Gramophone and other musical instrument parts, wireless details, automobile accessories, domestic articles, camera and cinematograph fittings and general instruments.

There are two main classes of alloys used:—(A) Zinc-hardened with tin and copper, and (B) Zinc-hardened with copper and aluminium. The actual composition varies with the work to be done. Special more-complex alloys are sometimes used, but the following can be regarded as typical of the two classes concerned:—(A) Tin, 7 to 10 per cent.; copper, 4 to 7 per cent.; and zinc, balance. (B) Copper, 3 to 5 per cent.; aluminium, 4 to 4.5 per cent.; and zinc, balance.

In general, Class (A) are used where dimensional accuracy is of the greatest importance; Class (B) where strength and toughness are the chief consideration.

The most notable contribution to the available information on die casting at the moment is the series of Papers presented to the Institute of Metals at the Autumn Meeting at Liverpool in September last year. The Papers report work carried out by the British Non-Ferrous Research Association, with the active support of the Department of Scientific and Industrial Research and the valuable co-operation of the manufacturers and their associations.

The Papers deal with three distinct sections of the industry:—(1) Die-Castings Alloys of Low Melting-Point by Russell, Goodrich, Cross and Allen, under the direction of Professor C. H. Desch, of Sheffield University; (2) Properties and Production of Aluminium-Alloy Die-Castings by Archbutt, Grogan and Jenkins, under the direction of Dr. W. Rosenhain at the National Physical Laboratory; and (3) Die-Casting of Copper-Rich Alloys by Genders, Reader and Foster, under the direction of Dr. Harold Moore, of the Research Department, Woolwich.

The Papers are arranged in this order because it is considered that it corresponds with the relative magnitude and commercial importance of present-day manufacture. The first Paper, dealing with alloys of low melting-point confines itself to zinc-base alloys of two types: (A) Those in which the hardening-constituents are tin and copper, and (B) examples of alloys employing aluminium and copper as hardeners, other constituents, such as nickel, cadmium, lead and magnesium, have been introduced as individual cases, as shown in Table I.

Pressure-casting was employed throughout. Flat test-pieces were made in sixteen alloys. The examination was for tensile strength, hardness, bending, porosity, and also as to the effect of casting temperature, temperature of mould, size of gate and vent and type of pull on lever. Further, the effects on the strength and on the permanency of dimensions after atmospheric ageing and of accelerated ageing by the action of hot air, hot moist air and steam at 100 deg. C.

The form of test-piece particularly in respect to the radius at the junction of head and parallel portion is most important. The pieces having a small radius broke at the shoulder. It was found that the most suitable form was a 2-in. parallel test length with 1.5-in. radius.

The alloys of the second class, having aluminium and copper as hardener, have about twice the tensile strength of those in which copper and tin are so employed, together with what is perhaps of more importance, a useful measure of ductility and toughness. Variations in the size and form of gate within reasonable limits were found not seriously to affect the strength of the test-pieces, but, as was shown in the discussion, are of importance in connection with industrial production. Temperatures of the metal in the bath did not greatly affect tensile-strength of test-piece casting, but high temperatures gave rise to surface pinholes.

It was elicited in the discussion that the relative temperature of the bath and mould is of importance; with moderately low temperature in the metal bath and a warm mould good results are obtained in usual circumstances. The type of pull leaves much to the skill and discretion of the operator, who from experience learns that some castings require a short, sharp pull and others a sustained and steady follow-through. Variation in actual composition in the casting was shown to have been obtained by manipulation of the lever when casting metal whilst passing through the long temperature-range of solidification.

It was found that the aluminium-copper-hardened alloys are more difficult to cast, requiring a stronger action on the lever, and in this, commercial manufacture had advanced beyond the resources at the disposal of research and had overcome the difficulty. The influence of the external surface which is chilled is very great on the strength and hardness of the casting. Machining away the surface alters the conditions in a serious manner.

Permanence of Zinc Base Die Castings.

It was shown that the prejudice against aluminium-copper-zinc alloys, which formerly existed, is not justified in the high-grade alloys now being produced, and that so far as can be authoritatively determined there is little difference between the two types of alloy under examination. It was further pointed out that a copper-tin-zinc alloy casting of a difficult design had been in use as a component of a commercial instrument for seven years, and although required to be accurate to 0.001 in. was found to be not sensibly altered in dimension or form.

TABLE II.—*Composition of Alloys under Investigation. Zinc Base.*

Alloy. Mark.	Cu	Sn	Al	Ni	Pb	Mg	Cd	Density.
6 RM	3.17	5.67	0.41	—	—	—	—	7.148
7 RM	3.16	7.40	0.36	—	—	—	—	7.143
8 RM	3.72	9.73	0.98	—	—	—	—	7.085
9 RM	3.07	13.83	0.44	—	—	—	—	7.070
10 RM	3.11	22.31	0.29	—	—	—	—	7.202
11	1.2	9.7	0.98	—	—	—	—	—
12	1.06	8.35	0.37	1.09	—	—	—	7.131
13	3.66	9.65	0.86	—	—	—	0.97	7.128
14	2.72	—	3.95	—	—	—	—	6.77
14B	5.07	0.28	4.64	—	—	—	—	6.73
15	5.14	—	4.16	—	—	—	—	6.85
16	7.02	—	4.02	—	—	—	—	6.905
17	3.03	—	3.87	—	0.80	—	—	6.78
17 AC	3.04	—	3.44	—	0.75	—	—	—
2 AE	3.02	—	4.07	—	—	0.095	—	—
2 AH	2.94	—	4.02	—	—	0.107	—	—

It is found that porous castings are more liable to dimensional change than sound castings. The rate of growth depends primarily on the condition of the casting—namely, its size and shape, its mass per unit of surface, its porosity, crystalline size, etc.; whilst the effect of composition alone is (within fairly wide limits) comparatively small. It is considered that the presence of certain impurities adversely affect the permanence of die castings in these alloys in addition to increasing the difficulty in the actual casting operation.

The second class of die castings, the aluminium alloys, so ably investigated by Archbutt and his co-workers, is of increasing interest. In the investigation gravity-feed was employed throughout, but here again commercial practice under scientific guidance is racing ahead of research reports, and pressure-feed is being employed with striking success. Naturally there is much to learn; unexpected difficulties arise; extended experience in tool and machine design as well as manipulation is demanded.

Five alloys were employed in the National Physical Laboratory investigation; the object was twofold. First to examine the properties of the products and determine the best method of production. Second to explore the phenomenon of hot-shortness, which is the ever-present cause of anxiety in production. The alloys were 4 per cent. copper, 8 per cent. copper, 12 per cent. silicon, 4 per cent. copper plus 3 per cent. silicon, and Y-alloy (copper 4 per cent. nickel 2 per cent., magnesium 1.5 per cent.). Two types of casting have been investigated: (A) a shouldered test-piece of circular section suitable for testing direct without machining; (B) a hollow tubular casting, requiring use of cores in moulding, and incorporating flanges and changes of section, features which cause difficulties in casting. Design and treatment of moulds, and conditions of working in respect to mould-temperatures, pouring, stripping, etc., and the effect of the different alloy compositions on these are described, together with the testing and properties of the castings obtained. To overcome defects due to air-locks, shrinkage, sticking of cores, etc., very careful control of the working conditions was necessary, including metal and

mould temperatures, rate of pouring, interval between filling the mould and operations of drawing cores, opening the mould and stripping.

By means of a practised team of workers these operations were carried out with the degree of accuracy needed, and considerable success was thus obtained. Satisfactory castings were produced in the tubular form from all the alloys studied. With the test-piece form castings of satisfactory mechanical strength were obtained in "Y"-alloy, 12 per cent. silicon and 4 per cent. copper, plus 3 per cent. silicon, but less satisfactory results were obtained with the binary copper-aluminium alloys owing to hot-shortness.

The moulds were of grey cast iron annealed, and the cores from wrought 3-per-cent. nickel steel. Morgan crucibles were used. Pyrometric control was employed and every precaution was taken to ensure uniform conditions, and a degree of scientific accuracy observed so that any part of the experiment may be repeated under similar conditions, a feature which is so valuable and which is a characteristic of the work of the Metallurgical Department of the N.P.L.

The moulds were dressed with either:—(A) Whiting 11 lbs., plumbago 1 lb. and water 4½ galls.; or (B) whiting 11 lbs., water-glass 18 fluid ozs. and water 4½ galls. The cores were dressed with:—Plumbago 8¾ lbs., commercial rouge 2¼ lbs. and water 4½ galls. The rate of pouring the metal was determined by trial. Over-rapid pouring causes air-locks, whilst too slow pouring causes incomplete filling, cold shuts, bad skin and flow marks. The results of test-pieces are set out in Table V.

These should be compared with results from 1-in. chill-cast bars.

The test-bars were cast in form, thus avoiding subsequent machining; all went well excepting the two binary alloys of aluminium and copper. These were weak, or hot short, and, due to contraction on solidification, suffered before they could be stripped (see Fig. 1). The typical casting was well chosen; it gave excellent comparative results and introduced many of the difficulties which occur in commercial or works practice. It is certain that the team of skilled workers who prepared the specimens appreciate the troubles of the works production man very thoroughly.

(To be continued.)

Table III.—*To show the Effect of Type of Pull on lever actuating Plunger.*

Alloy No.	Quick pull. Porosity. Per cent.	Quick pull. Tonsile strength. Tons/in.²	Slow pull. Porosity. Per cent.	Slow pull. Tensile strength. Tons/in.²		
6 RM ..	—	—	3.69	9.81		
7 RM ..	6.04	9.75	3.40	10.34		
8 RM ..	7.3	9.57	3.09	10.66		
9 RM ..	7.40	8.84	2.37	10.12		
10 RM ..	—	—	4.00	9.00		
11 ..	—	—	—	9.11		
12 ..	—	—	3.16	7.62		
14 ..	6.90	18.00	3.63	17.61	Standard gate.	Average of 20 tests.
14 ..	5.40	18.84	3.70	18.14	Enlarged gate.	" "
15 ..	7.37	19.16	2.33	20.73	Standard gate.	
15 ..	4.87	21.22	4.23	20.96	Enlarged gate.	
16 ..	6.70	21.11	4.17	22.10	Standard gate.	
16 ..	4.80	22.13	3.27	23.24	Enlarged gate.	
17 ..	4.25	17.51	4.10	17.24	Enlarged gate.	Average of 20 tests.
ZAE ..	—	22.02	—	—	Enlarged gate.	" 11 "
ZAH ..	—	22.27	—	—	Enlarged gate.	" 5 "

Table IV.—*Mechanical Properties of Die-cast Test-Pieces. Tested direct Without Machining.*

	Condition.	M.S. Tons per sq. in.	E. Per cent. on 2 in.
	Large Test-Piece.		
"Y"-alloy ..	As cast ..	14–14.5	1.5–2
	Heat-treated ..	17–17.5	2
Si 12 per cent.	Modified ..	13–13.5	10
Cu 4 per cent, Si 3 per cent. ..	As cast ..	9.5–10	1.5–2
	Heat-treated ..	14·5	2
	Small Test-Piece.*		
"Y" alloy ..	As cast ..	14–14.5	1.5
	Heat-treated ..	18–19	2
Si 12 per cent...	Modified ..	13.5–14	10
Cu 8 per cent. ..	As cast ..	9–10.5	3–4
Cu 4 per cent. Si 3 per cent. ..	As cast ..	9.5–10	4–5
	Heat-treated ..	14.5	3

* Elongation measured on 1-in. gauge length.

Table V.—*Comparative Tensile Properties of the Aluminium Alloys Investigated, in the Form of 1-in. diam. Chill-cast Bars.*

Alloy.	M.S. Tons per sq. in.	E. Per cent. on 2 in.
Cu 4 per cent., Si 3 per cent. ..	12	5
"Y" alloy	14	2
"Y" alloy (heat-treated) ..	20	5
Cu 4 per cent.	10	12
Cu 4 per cent. (heat-treated) ..	16	22
Cu 8 per cent.	10	4
Si 12 per cent. (modified) ..	14	12

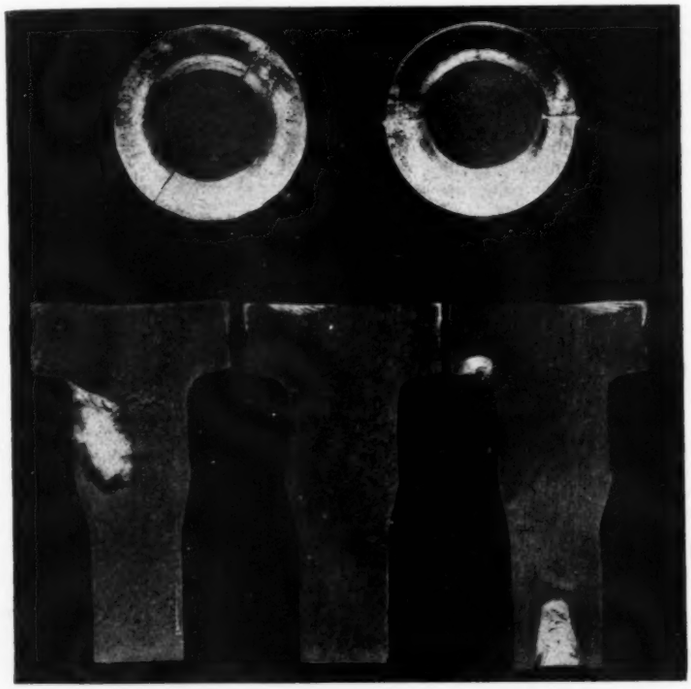


Fig. 1.

Italian Iron and Steel Trade in May.

By Our Genoa Correspondent.

Further noteworthy progress was possible during May in the rate of production of the Italian iron and steel works, especially as some establishments worked with modernised plant of recent introduction. The number of orders received from the State Railways was very encouraging in the case of rails, wheels and axles, structural material, rolling stock, etc. Besides this, there was also a certain request for plates from the shipbuilding yards, and orders of some importance for concrete bars, rolled joists, tubing, etc., from the building industry.

The Italian demand for Cleveland pig-iron was brisk. It was, however, often impossible to arrange deliveries with the speed desired by Italian consumers, some of the producers having sold their output until next September. The modest quantity in the hands of merchants was often negotiated for, without, however, being always in a position to arrange delivery. East Coast hematite pig-iron was also in strong demand, but even in this case prompt deliveries could not be arranged. Italy could place orders of some importance with Poland and Germany, although these countries were themselves in need of their own production. Luxemburg and French pig-iron was also available, but only in small quantities. The inland producers benefited, therefore, very largely by the situation, and were even able to lower slightly their prices, due to the possibility of reducing their costs of production by putting new furnaces into commission.

Quotations on the Milan market on June 6 were as under, in lire per metric ton (the average exchange rate being about 92.60 lire to the £):—Black sheets (4 mm.) remained at 1,200 (£12 19s.); galvanised sheets (No. 20) rose from 1,800 to 1,850 (£19 19s. 6d.); wire rose from 1,040 to 1,080 (£11 13s. 3d.); rods fell from 1,150 to 1,100 (£11 17s. 7d.); boiler tubes fell from 2,850 to 2,800 (£30 4s. 9d.); Italian welded tubes fell from 1,900 to 1,850 (£19 19s. 6d.); and Italian seamless tubes fell from 2,400 to 2,350 (£25 7s. 6d.).

Strikes in the German Steel Industry.—Strikes during 1928 cost the German Union of Metal Workers, which possesses a membership of nearly one million, 16,000,000 mks. (£800,000). The total funds of the union for the same year amounted to 80,500,000 mks. (£4,025,000).

The Influence of Chromium in Cast Iron.*

By J. W. Donaldson, D.Sc.

Introduction.

In a recent investigation carried out by the author, and presented as the French Exchange Paper on behalf of the Institute of British Foundrymen in 1928,[1] the influences of total carbon, silicon, phosphorus and manganese respectively on the carbon decomposition and volume changes of cast iron were determined. These investigations were continued to determine the influence of various special element-additions, and in the present Paper the influence of chromium on heat-resisting and other properties is considered.

The use of chromium in cast iron was first experimented with by Keep,[2] who added chromium to the extent of 2 per cent., and found that there was a slight increase in strength up to 1 per cent., then a decrease, while the shrinkage was increased when less than 1 per cent. was added. Campion,[3] in a later investigation, found that 1 per cent. of chromium increased the strength and hardness, and also the amount of combined carbon. Hurst[4] states that in an iron containing 1 per cent. of silicon an addition of 0.9 per cent. chromium rendered the fracture quite mottled, and that 4 per cent. added to an iron containing 1.5 per cent. silicon rendered the fracture perfectly white, and that drastic annealing at 900 to 950 deg. C. failed to produce graphite.

Smalley,[5] in his systematic investigations with special element additions to cast iron, added chromium to ordinary grey cast iron and to cylinder iron. The influence of chromium additions of 0.11 and 0.15 per cent. respectively was to increase the strength and hardness slightly, while with the larger addition of 0.78 per cent. to the ordinary iron the tensile strength fell, the transverse strength was affected slightly, and the

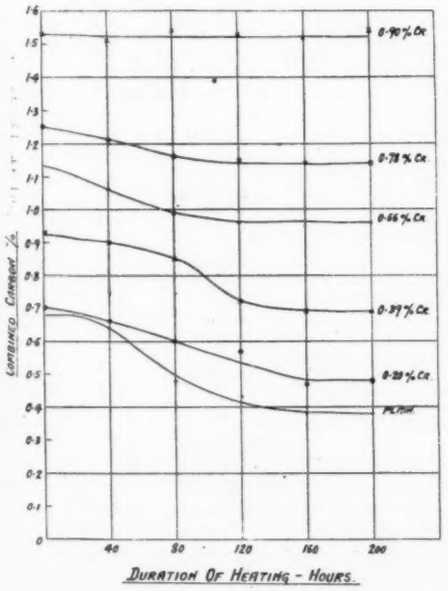
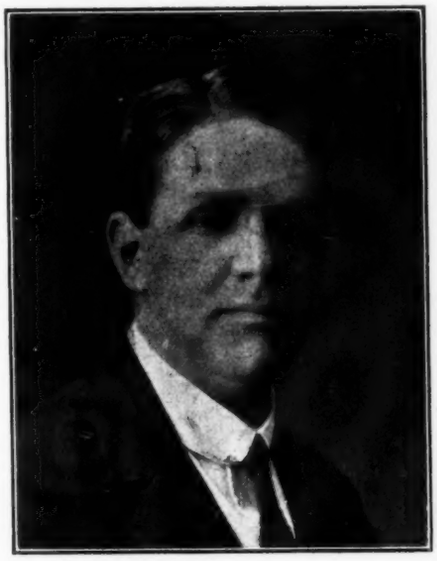


FIG. 1.—HEAT TREATMENT AT 450 DEG. C.

Brinell hardness increased. A similar addition of chromium to the cylinder iron produced an increased transverse strength and Brinell hardness, but little change in the tensile strength. Experiments by Piwowarsky[6] show that with up to 0.5 per cent. of chromium the strength and shock-resisting properties of cast iron are increased to the extent of about 10 per cent., while the hardness increases from 20 to 25 per cent. Hamasumi's[7] investigations show that the addition of 0.4 per cent. of chromium raises the tensile strength of cast iron from 16.5 to 22.8 tons per sq. in. without materially altering the structure, and that cast iron is not rendered brittle by chromium up to this amount.



DR. J. W. DONALDSON.

The results of these investigations establish denitely that 0.5 per cent. of chromium in the presence of 1 to 2 per cent. of silicon increases the tensile and transverse strengths and the hardness of grey cast iron. This increase is brought about by the chromium preventing the formation of graphite and producing a more stable double carbide of iron, and chromium. With the exception of Hurst's work, however, little has been done on the heat-resisting properties of chromium cast irons, and it was with those properties and the thermal and corrosion properties that the following experiments deal.

TABLE I.—*Analyses and Tests.*

Mark.	P	Cr 1.	Cr 2.	Cr 3.	Cr 4.	Cr 5.
T.C., per cent. ..	3.16	3.19	3.17	3.16	3.24	3.21
C.C., per cent. ..	0.68	0.70	0.93	1.13	1.25	1.53
Gr, per cent. ..	2.48	2.49	2.24	2.03	1.99	1.68
Si, per cent. ..	1.48	1.42	1.40	1.42	1.60	1.48
S, per cent. ..	0.054	0.049	0.040	0.07	0.058	0.041
P, per cent. ..	0.70	0.70	0.69	0.68	0.77	0.66
Mn, per cent. ..	0.97	0.96	0.97	1.00	0.95	0.95
Cr, per cent. ..	Nil	0.20	0.39	0.66	0.78	0.90
M.S.,tons per sq.in.	16.6	17.0	18.4	17.8	15.8	13.4
Br. No.	223	235	248	255	262	277

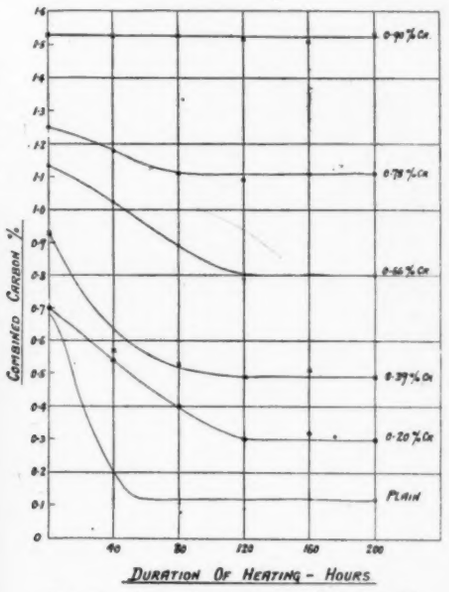


FIG. 2.—HEAT TREATMENT AT 550 DEG. C.

Cast Irons Used.

To an ordinary cast iron containing approximately 3.20 per cent. of carbon, 1.5 per cent. silicon, 0.7 per cent. phosphorus and 1.0 per cent. manganese, chromium was added to obtain a series of irons containing 0.20, 0.39, 0.66, 0.78 and 0.90 per cent. of chromium respectively. The exact composition of these irons and the plain iron, together with their tensile strengths and Brinell hardness, is given in Table I.

As the chromium increased up to 0.39 per cent. the tensile strength increased from 16.6 tons to a maximum of 18.4 tons, decreasing with further chromium additions to 13.4 tons with 0.90 per cent. chromium. The Brinell hardness increased uniformly from 223 in the plain iron to 277 in the 0.9 per cent. chromium iron. The irons containing over 0.4 per cent. chromium have a mottled fracture, and under the microscope showed the presence of free cementite. Difficulty was also experienced in machining those irons.

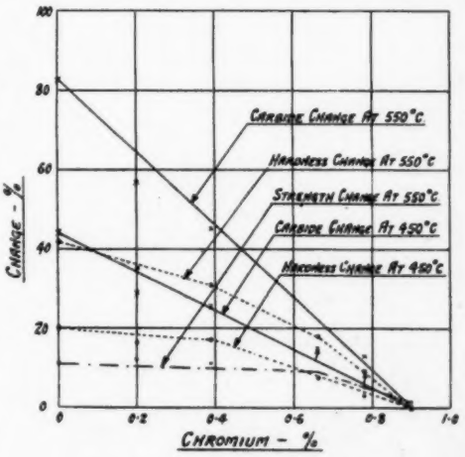


FIG. 3.—PERCENTAGE CHANGES.

The irons were all cast in dry-sand moulds into bars 16 in. by 1¼ in. dia. The chromium

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was added in the ladle, as 65 per cent. ferro-chrome, and the irons were re-melted in crucibles before casting to render them uniform.

FIG. 4.—P. AS CAST. × 540.

They were all cast at approximately the same temperature and under similar conditions.

Heat-Treatment Changes.

The methods of testing were those adopted in previous tests with plain cast irons. Bars from each of the irons were heated in an electric resistance furnace for 8 hours per day to 450 deg. C., cooled overnight, and re-heated on the following day to the same temperature. At the end of each 5 days' or 40 hours' heating, the total and combined carbon of each iron was estimated, the Brinell-hardness determined, and, where material permitted, the tensile strength determined. Similar tests were carried out on bars at 550 deg. C. The results are given in Tables II and III and represented graphically in Figs. 1 and 2, while the percentage changes produced by all the irons are given in Table IV and graphically in Fig. 3.

TABLE II.—*Heat Treatment at 450 deg. C.*

Chromium irons.		Duration of heating in hours.					
Cr per cent.	—	0	40	80	120	160	200
Plain ..	T.C. per cent.	3.16	3.17	3.17	3.19	3.13	3.15
	C.C. per cent.	0.68	0.64	0.48	0.43	0.38	0.38
	Tens. M.S...	16.6	16.2	15.7	15.3	15.4	15.5
	Br. No. ..	223	212	197	183	183	179
Cr 1, 0.20 per cent.	T.C. per cent.	3.19	3.18	3.16	3.16	3.13	3.21
	C.C. per cent.	0.70	0.66	0.60	0.57	0.49	0.50
	Tens. M.S...	17.0	16.8	16.4	—	16.0	15.9
	Br. No. ..	235	223	212	197	197	197
Cr 2, 0.39 per cent.	T.C. per cent.	3.17	3.18	3.17	3.18	3.16	3.20
	C.C. per cent.	0.93	0.90	0.85	0.72	0.69	0.69
	Tens. M.S...	18.4	17.9	17.5	17.4	17.2	17.3
	Br. No. ..	248	235	212	207	201	207
Cr 3, 0.66 per cent.	T.C. per cent.	3.16	3.14	3.16	3.14	3.10	3.09
	C.C. per cent.	1.13	1.06	0.99	0.96	0.95	0.96
	Tens. M.S...	17.8	—	—	—	—	—
	Br. No. ..	255	241	235	235	235	235
Cr 4, 0.78 per cent.	T.C. per cent.	3.24	3.30	3.20	3.26	3.28	3.29
	C.C. per cent.	1.25	1.21	1.16	1.15	1.14	1.14
	Tens. M.S...	15.8	—	—	—	—	—
	Br. No. ..	262	255	255	255	255	255
Cr 5, 0.90 per cent.	T.C. per cent.	3.21	3.16	3.24	3.20	3.20	3.21
	C.C. per cent.	1.53	1.51	1.54	1.53	1.52	1.54
	Tens. M.S...	13.4	—	—	—	—	—
	Br. No. ..	277	277	277	227	277	777

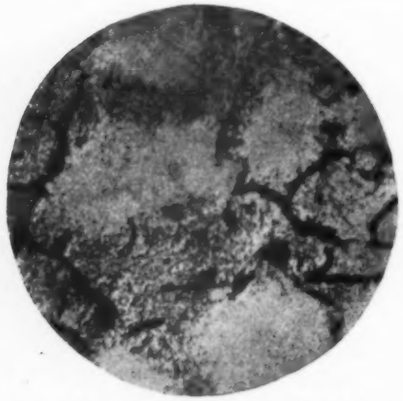


FIG. 5.—P. HEAT TREATED FOR 200 HRS. AT 550 DEG. C. × 540.

TABLE III.—*Heat Treatment at 550 deg. C.*

Chromium irons.		Duration of heating in hours.					
Cr per cent.	—	0	40	80	120	160	200
Plain ..	T.C. per cent.	3.16	3.13	3.16	3.15	3.15	3.14
	C.C. per cent.	0.68	0.12	0.11	0.09	0.12	0.12
	Tens. M.S...	16.6	15.8	15.1	14.8	14.6	14.8
	Br. No. ..	223	138	129	129	125	129
Cr 1, 0.20 per cent.	T.C per cent.	3.19	3.13	3.17	3.15	3.17	3.17
	C.C. per cent.	0.70	0.54	0.40	0.30	0.32	0.30
	Tens. M.S...	17.0	16.3	15.8	15.3	15.1	15.1
	Br. No. ..	235	197	171	152	152	152
Cr 2, 0.39 per cent.	T.C. per cent.	3.17	3.16	3.22	3.20	3.15	3.21
	C.C. per cent.	0.93	0.57	0.53	0.49	0.51	0.49
	Tens. M.S...	18.4	17.9	17.4	16.8	16.4	16.4
	Br. No. ..	248	207	174	170	170	170
Cr 3, 0.66 per cent.	T.C. per cent.	3.16	3.17	3.10	3.12	3.15	3.13
	C.C. per cent.	1.13	1.02	0.89	0.79	0.80	0.80
	Tens. M.S...	17.8	—	—	—	—	16.3
	Br. No. ..	255	235	217	212	212	212
Cr 4, 0.78 per cent.	T.C. per cent.	3.24	3.23	3.27	3.21	3.19	3.22
	C.C. per cent.	1.25	1.18	1.11	1.09	1.11	1.11
	Tens. M.S...	15.8	—	—	—	—	15.0
	Br. No. ..	262	255	248	248	248	248
Cr 5, 0.90 per cent.	T.C. per cent.	3.21	3.20	3.20	3.22	3.25	3.20
	C.C. per cent.	1.53	1.53	1.53	1.52	1.51	1.53
	Tens. M.S...	13.4	—	—	—	—	13.2
	Br. No. ..	277	277	277	277	277	277

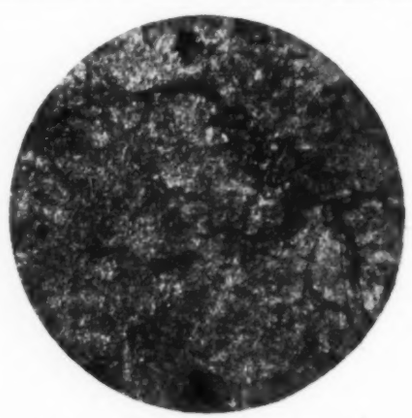


FIG. 6.—CR. 2. AS CAST. × 540.

Consideration of Table II and Fig. 1, which deal with the experiments carried out at 450 deg. C., show that as the chromium content increases the stability of the combined carbon under temperature is increased. In the plain iron decomposition takes place to the extent of 44 per cent. and is more or less complete after 160 hours' heating. With the addition of 0.2 per cent. of chromium decomposition is more uniform although the amount is less, 28 per cent., and is complete after 160 hours' heating. The 0.39 per cent. chromium iron shows a 26 per cent. decomposition after 120 hours, while additions of 0.66 and 0.78 per cent. chromium reduce the amount of decomposition still further to 15 and 9 per cent., equilibrium conditions being attained after 80 and 40 hours' heating respectively. With 0.90 per cent. chromium the combined carbon remains unchanged after 200 hours' heating and the Brinell-hardness decrease,

FIG. 7.—CR. 2. HEAT TREATED FOR 200 HRS. AT 550 DEG. C. × 540.

which has diminished from 20 per cent. in the plain iron as the chromium increases, is *nil*.

Similarly at 550 deg. C., with 0.90 per cent. chromium, there is no change in the combined carbon content and the Brinell-hardness remains

TABLE IV.—*Percentage Changes at 450 deg. and 550 deg. C.*

Temperature.	Iron.	Duration of heating in hrs.	C.C decrease.	Tens. strength decrease.	Brinell hardness decrease.
—	—	—	Per cent.	Per cent.	Per cent.
450 deg. C.	Plain	160	44.1	6.6	19.8
	Cr 1, 0.20 per cent. Cr ..	120	28.6	6.5	16.2
	Cr 2, 0.39 per cent. Cr ..	120	25.8	6.0	16.5
	Cr 3, 0.66 per cent. Cr ..	80	15.1	—	7.8
	Cr 4, 0.78 per cent. Cr ..	40	8.8	—	2.7
	Cr 5, 0.90 per cent. Cr ..	200	Nil	—	Nil
550 deg. C.	Plain	40	82.4	10.9	42.1
	Cr 1, 0.20 per cent. Cr ..	120	57.1	11.2	35.3
	Cr 2, 0.39 per cent. Cr ..	120	47.3	10.9	31.4
	Cr 3, 0.66 per cent. Cr ..	80	29.2	8.4	16.8
	Cr 4, 0.78 per cent. Cr ..	80	11.2	5.1	5.4
	Cr 5, 0.90 per cent. Cr ..	200	Nil	1.5	Nil

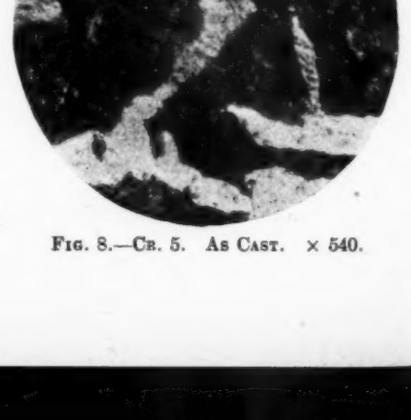


FIG. 8.—CR. 5. AS CAST. × 540.

the same, the tensile strength diminishing by 1.5 per cent. (Table III and Fig. 2). The other chromium additions of 0.20, 0.39, 0.66 and 0.78 per cent. chromium produce combined carbon decompositions of 57, 47, 29 and 11 per cent. respectively, which is considerably less than the 82 per cent. decomposition in the plain iron. This decrease in the combined carbon content is reflected in the strength and hardness properties, particularly with additions of over 0.4 per cent. chromium. The rate of decomposition is slower in the chromium irons, equilibrium conditions being attained after approximately 100 hours' heating, whereas in the plain iron the decomposition that takes place is complete after 40 hours.

These results, obtained by chemical and mechanical tests, are confirmed by microscopic examination. Figs. 4 and 5 show the structure of the plain iron as cast and after 200 hours' heat treatment at 550 deg. C. After treatment the pearlite shows considerable decomposition,

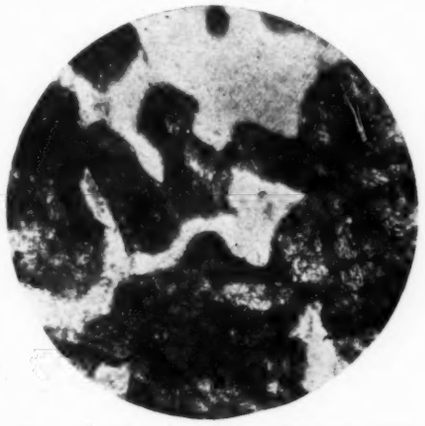


FIG. 9.—CR. 5. HEAT TREATED FOR 200 HRS. AT 550 DEG. C. × 540.

the graphite is increased in size, and there is oxidation of the iron in the vicinity of the graphite. In the 0.39 per cent. chromium iron, Figs. 6 and 7, cast and heat-treated, the amount of pearlite unaffected is considerably greater; the graphite shows little change with little or no oxidation of iron. The two microphotos of the 0.90 per cent. chromium iron, Fig. 8, as cast, and Fig. 9, heat-treated, show practically no variation in structure.

Summing up generally, it will be noted, Fig. 3, that as the chromium content of grey cast iron is increased, the influence of the chromium is to stabilise the combined carbon, both at 450 and 550 deg. C., complete stability being attained with 0.90 per cent. of chromium. This increased stability of the combined carbon under temperature is no doubt due to the presence, according to the recent work of Westgren, Phragmen and Negresco,[8] of chromium in the cementite of the pearlite and affects the heat-resisting properties of the irons enabling them to retain both their strength and hardness.

Volume Changes.

The volume changes were carried out on bars accurately machined to 6 in. long by 1 in. dia. These were heated in an electric-resistance furnace to 550 deg. for eight hours per day, cooled over night and reheated the following day. At the end of every 40 hours' heating the bars were measured and the volumes determined. The results are given in Table V and Fig. 10.

Consideration of these results show that while the plain iron has a volume increase, all the irons containing chromium show contraction after prolonged heating. The irons containing 0.20 and 0.39 per cent. of chromium contract to the extent of 0.15 and 0.27 per cent. respectively. Further addition of chromium to 0.66 per cent. reduces the contraction to 0.06 per cent., while still further additions to 0.78 and 0.90 per cent. increase this reduced contraction to 0.18 and 0.23 per cent. respectively.

These results appear to be very erratic and, at first, it is difficult to conceive why the increase of chromium from 0.39 to 0.66 per cent. should produce a lower volume contraction. It is possible that the explanation may be found

TABLE V.—*Volume Changes.*

Cr. Per cent.	No. of heatings.	Length. In.	Dia. In.	Vol. Cub. in.	Change. Per cent.
Nil	0	6.0000	1.0000	4.710	—
	5	6.0004	1.0005	4.715	0.11
	10	6.0011	1.0006	4.716	0.13
	15	6.0010	1.0006	4.716	0.13
	20	6.0011	1.0006	4.716	0.13
	25	6.0011	1.0006	4.716	0.13
0.20	0	6.0000	1.0000	4.710	—
	5	5.9999	0.9998	4.708	0.04
	10	5.9997	0.9997	4.707	0.06
	15	5.9990	0.9993	4.703	0.15
	20	5.9988	0.9994	4.703	0.15
	25	5.9988	0.9994	4.703	0.15
0.39	0	6.0000	1.0000	4.710	—
	5	5.9992	0.9998	4.707	0.06
	10	5.9985	0.9997	4.706	0.08
	15	5.9979	0.9992	4.701	0.18
	20	5.9980	0.9989	4.698	0.25
	25	5.9978	0.9988	4.697	0.27
0.66	0	6.0000	1.0000	4.710	—
	5	6.0004	1.0001	4.711	+0.02
	10	6.0000	0.9999	4.709	−0.02
	15	5.9998	0.9997	4.707	0.06
	20	5.9998	0.9997	4.707	0.06
	25	5.9997	0.9997	4.707	0.06
0.78	0	6.0000	1.0000	4.710	—
	5	6.0001	1.0000	4.710	—
	10	6.0000	1.0000	4.710	—
	15	5.9997	0.9997	4.706	0.06
	20	5.9989	0.9993	4.703	0.15
	25	5.9984	0.9992	4.701	0.18
0.90	0	6.0000	1.0000	4.710	—
	5	5.9998	0.9998	4.708	0.04
	10	5.9995	0.9995	4.705	0.10
	15	5.9992	0.9990	4.700	0.21
	20	5.9990	0.9989	4.699	0.23
	25	5.9991	0.9989	4.699	0.23

by considering the general structure of the irons. The two lower-chromium irons are essentially grey cast irons having a structure consisting of pearlite and graphite with a small amount of free ferrite, whereas the structure of the higher-chromium irons consist of pearlite, graphite and

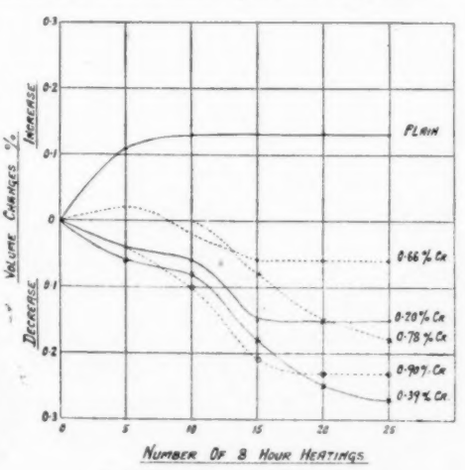


FIG. 10.—VOLUME CHANGES.

free cementite. Experiments have shown that white cast irons containing large proportions of free cementite and no graphite are not affected by volume changes, so that the mottled nature of the three higher-chromium irons may have slowed down the volume contraction-changes due to the chromium.

Considering next the contraction-changes due to the chromium. This, phenomenon, as yet, cannot be explained or defined. Andrew and Hyman[9] state as a result of their work on the growth of special cast irons at 900 deg. C., that chromium when added in sufficient quantity

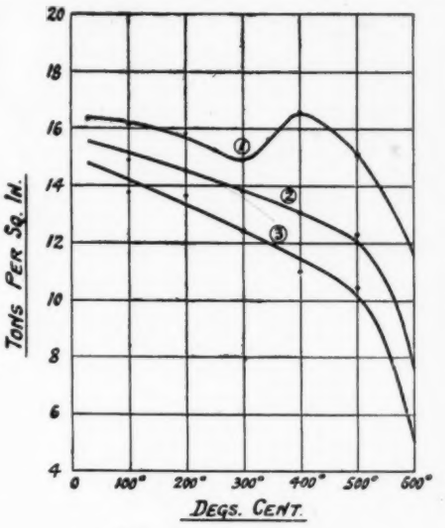


FIG. 11.—PLAIN IRON.

(1) AS CAST.
(2) HEAT TREATED FOR 200 HRS. AT 450 DEG. C.
(3) HEAT TREATED FOR 200 HRS. AT 550 DEG. C.

(1.5 per cent.) considerably retards and reduces growth but does not prevent it; and the author has found that heating the 0.39 per cent. chromium iron to 800 deg. C. produces a small volume increase. Growth in grey cast iron is produced by decomposition of the combined carbon of the pearlite and increase in the size of the graphite lamellæ and these changes may or may not be followed by oxidation of the iron in the vicinity of the graphite. All the chromium irons are subject to varying degrees of combined carbon decomposition excepting the 0.90 per cent. iron, but microscopic examination shows little or no change in the nature of the graphite and no oxidation. It would, therefore, appear that the contraction change which

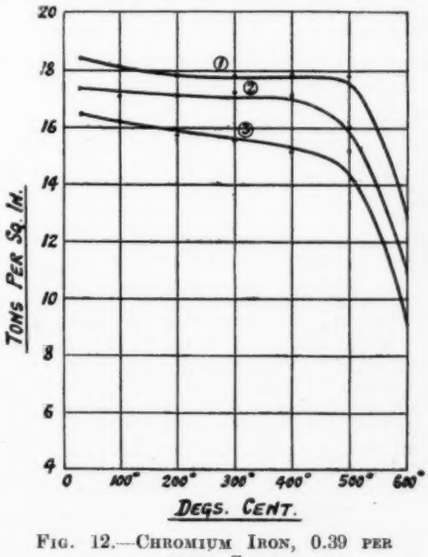


FIG. 12.—CHROMIUM IRON, 0.39 PER CENT. CR.

(1) AS CAST.
(2) HEAT TREATED FOR 200 HRS. AT 450 DEG. C.
(3) HEAT TREATED FOR 200 HRS. AT 550 DEG. C.

takes place at temperatures below the critical-range is in some manner due to the chromium and exceed the volume change produced by combined carbon decomposition. What the nature of the change is cannot be determined by ordinary microscopic investigations and is probably molecular.

From the results obtained it would, therefore, appear that two main factors operate in the volume changes of those chromium irons. First there is the contraction phenomenon due to the chromium, as yet not explanable; and second, the change due to the structural nature of the irons. This latter point, the growth of a purely

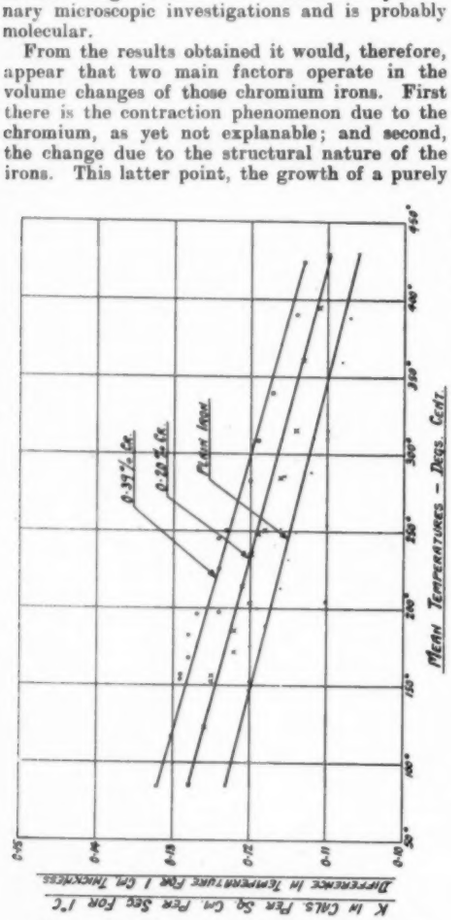

0·37% Cr.
0·22·5% Cr.
Plain Iron.
Mean Temperatures – Degs. Cent.
K in Cals Per Sq. Cm. Per Sec. for 1°C Difference in Temperature for 1 Cm. Thickness.

Fig. 13.—Thermal Conductivities of Plain and Chromium Irons. As Cast.

grey cast iron as compared with the growth of a mottled cast iron of a similar composition and the omitting of elements, such as chromium, which may produce complication, requires further investigation, and might also explain the erratic volume changes that are known to occur in irons of a border-line composition.

Elevated Temperature Tests.

The strength of plain and chromium cast irons at elevated temperatures has been dealt with by the author in his Paper on "Special Cast Irons,"[10] and the curves obtained for the plain iron and the iron containing 0.39 per cent. of chromium are reproduced in Figs. 11 and 12. It will be seen that the effect of this chromium addition is to increase the strength of cast iron at elevated temperatures, both in its "as cast" and heat-treated conditions. The strength is maintained to 500 deg. C., whereas in the iron containing no chromium it falls off at 400 deg. C. The breaking stresses of the two irons, when tested at 400 deg. after 200 hours' heat-treatment at 550 deg. C., are 11.0 and 15.6 tons per sq. in. respectively, and show the beneficial effects of a small chromium addition. It will also be noted that the depression occurring in the "as cast" of the plain iron is practically eliminated by the chromium.

Thermal Conductivity.

In a like manner the thermal conductivity of the plain iron and the two chromium irons containing 0.20 and 0.39 per cent. of chromium have been fully dealt with in a previous Paper on "The Thermal Conductivities of Grey Cast Irons,"[11] and again the curves obtained are reproduced in Fig. 13. These curves show that the thermal conductivity value for the plain iron at 100 deg. C. of 0.122 is increased by the chromium additions to 0.127 and 0.132, and at 400 deg. C. the K values of the two chromium irons are 0.111 and 0.114, as against 0.107 for the plain iron. Chromium, therefore, tends to increase the thermal conductivity of grey cast iron.

Corrosion Tests.

In view of the many advantages which have been gained in steel in reducing corrosion by additions of chromium, it was considered of interest to subject the various chromium irons, together with the plain iron, to a series of corrosion tests, to determine, if possible, if such small additions of chromium had any influence on cast iron.

Test-pieces, 25 mm. long by 20 mm. dia., were machined from each iron, buffed, polished and immersed in the following solutions for 28

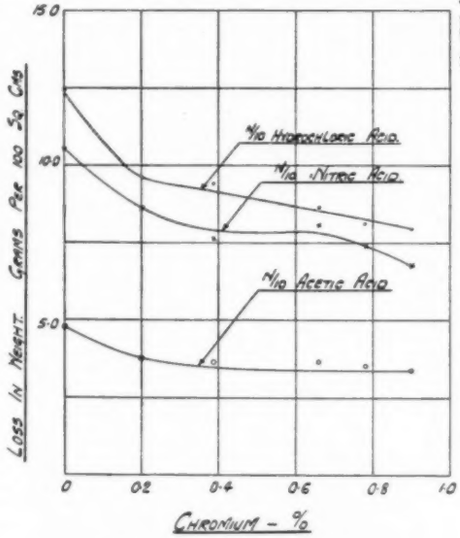


Fig. 14.—Corrosion Tests.

days at 60 deg. F. (15 deg. C.). The solutions were N/10 hydrochloric acid, N/10 nitric acid, N/10 acetic acid, tap water, sea water, and N/10 ammonium chloride. At the end of the period the test-pieces were washed, dried in alcohol and the loss in weight determined. Three tests were carried out on each iron in each solution,

Table VI.—*Corrosion Tests.*

Loss in Weight. Grams per 100 sq. cms. of Surface Area, after 28 days.

Cast iron.	Corroding media.					
	N/10 HCl	N/10 HNO_3	N/10 HA	Tap water.	Sea water.	N/10 AmCl
Plain ..	12.48	10.51	4.77	0.30	0.78	0.84
0.20 per cent. Cr	9.53	8.62	3.72	0.23	0.42	0.69
0.39 per cent. Cr	9.48	7.68	3.60	0.25	0.32	0.72
0.66 per cent. Cr	8.67	8.06	3.67	0.22	0.35	0.73
0.78 per cent. Cr	8.09	7.31	3.51	0.21	0.31	0.68
0.90 per cent. Cr	7.91	6.75	3.39	0.21	0.29	0.65

and from the average weights obtained the loss in weight per 100 sq. cm. determined. The results were given in Table VI and Figs. 14 and 15.

The general influence of the chromium additions is to effect a slight beneficial effect as regards resistance to corrosion. This influence is most marked in the case of sea water, and least noticeable with tap water, N/10 acetic acid and N/10 ammonium chloride. The influence of chromium in retarding the corrosion in all cases follows the addition of 0.20 per cent. chromium and increases slowly as the chromium content increases.

These results are somewhat in accordance with the results obtained by Kotzschke and Piwowarsky[12] in their series of experiments on the corrosion of cast iron. These investigators found that chromium exerted a beneficial influence on the resistance of cast iron to acids, when present to the extent of 1 per cent., but with castings subjected to the rusting effect of solutions of salts, chromium is of little advantage. In general it would appear as if chromium would have to be present in considerably larger amounts than 0.90 per cent. to exert any marked influence on the corrosion properties of cast iron.

Summary.

Chromium added to grey cast iron in quantities up to 0.90 per cent. increases the stability of the combined carbon at temperatures up to 550 deg. C. This increase in stability is probably due to the presence of chromium carbide in the cementite of the pearlite, and is reflected in the increased strength both at ordinary

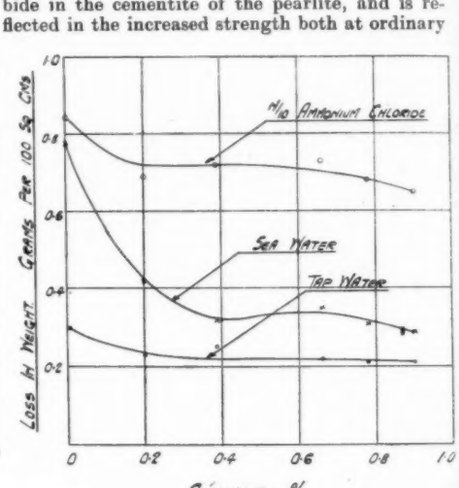


Fig. 15.—Corrosion Tests.

and elevated temperatures and in the Brinell hardness. Better heat-resisting irons are, therefore, obtained, but there is difficulty in machining irons with over 0.4 per cent. of chromium.

The influence of chromium on volume changes at temperatures below the critical range is erratic, but the general effect is to produce a contraction. The nature of this contraction is difficult to explain or define. With chromium up to 0.4 per cent. the thermal conductivity is increased by about 8 per cent.

Small additions of chromium reduce very slightly the corrosion of grey cast iron. The effect is most noticeable with sea water, and to a lesser extent with strong acids. With weak acid, tap water, and ammonium chloride little advantage is gained.

The author thanks Mr. James Brown, C.B.E., and the other directors of Scotts' Shipbuilding and Engineering Company, Limited, Greenock, for permission to carry out the above investigations.

A message from Sydney states that the directors of the Australian Iron and Steel Company, Limited, have increased the issued capital of the company to £3,700,000 by the issue of 600,000 ordinary £1 shares. This makes the number of ordinary shares issued 2,700,000 and the preference 1,000,000. The new issue has been offered to the ordinary shareholders, comprising the Hoskins, Dorman Long, Howard Smith and Baldwin companies, which have subscribed for the whole amount. The additional capital is required for increasing the scope of the company's activities.

Coal-Dust as Applied to Moulding Sand.*

By Ben Hird, M.I.Brit.F.

This Paper is an attempt to prove, by practical experiments, the action of coal-dust during the pouring of moulds which have been faced with sand containing a percentage of this material, and the changed condition of the sand and coal-dust after use. So far, the author has been unable to find any data of sustained investigations of the action of coal-dust in sand moulds. Practically every foundryman has formed his own ideas as to what actually takes place, the most prevalent idea being that a slight film of gas, or smoke, on the face of the mould, prevents the molten metal fusing the silica grains, giving to the casting a clean blue skin, instead of the rough grey appearance when no coal-dust is used.

Particulars of the ingredients used in these experiments are:—

Sand.—The sand used, throughout, was Stourbridge Red sand, of medium grade, as received from the quarry. The sand was dried and passed through a ¼-in. mesh sieve to remove lumps. Coal-dust was well mixed in, and 5 per cent. of water added.

The sand was tested as follows:—

Sieve Tests.—Sieve tests were made on the raw sand as received and on the dried raw sand (dried for one hour at 110 deg. C.) with the following results. The sieves used were the old British standard. This gives an idea of grain size.

	Red sand as received.	Dried red sand.
Left on 30 mesh ..	0.3	0.3
„ 60 „ ..	13.8	21.0
„ 90 „ ..	34.1	37.0
„ 120 „ ..	27.5	23.5
„ 180 „ ..	17.2	13.3
Passing 180 „ ..	6.1	4.2

Permeability Tests.—The permeability of the raw sand rammed to a density of 1.6 in the standard apparatus of the Cast Iron Research Association was 35. This is the time in seconds taken by a gas to penetrate a standard core 8 in. long and 2¼ in. dia. contained in a cylinder. The volume of the cylinder, and hence of its containing core, is 800 c.c., and, therefore, the density of the core is readily obtained by dividing the weight of the sand taken by the volume. In this case the weight was 1,280 gms. Alternatively, a given density can be obtained by weighing out a particular amount of sand, and a little experience soon enables this to be used in just filling the cylinder with a uniform ramming.

Strength Tests.—The strength of the sand taken on a core 1 in. dia., 2 in. long, in the standard compression apparatus of the Cast Iron Research Association, is shown in Fig. 1. This gives the compression strength of the raw sand, both in the unmilled state and after milling for ten minutes. The improvement after milling will be noted. The strength is given for several ramming densities and, of course, the higher the ramming the stronger the sand. The whole of the strength tests were taken on a standard moisture content of 5 per cent.

To eliminate any unknown quantities, used floor sand, *i.e.*, black sand, was discarded.

Coals.

Three coals were ground separately to produce the dust for these experiments:—

		Per cent.
Tirpentwys ..	Volatile	30.6
	Ash	10.4
	Carbon by difference ..	59.0
Treharris ..	Volatile	12.3
	Ash	16.10
	Carbon by difference ..	71.60
Anthracite ..	Volatile	6.6
	Ash	9.70
	Carbon by difference ..	83.70

* A Paper presented to the International Foundrymen's Congress.

Each of these coal dusts were divided into three grades, or grists, as follows:—(1) All that passed through a 40 meshes to the linear inch

MR. BEN HIRD.

sieve; (2) between 40 and 28, and (3) between 28 and 12—that is, fine, medium and coarse grists.

The results of these tests are set out in detail in Table I. The numbers marked on the soleplates in Fig. 2 refer to the corresponding test numbers in Table I.

To explain as briefly as possible the data given in Table I:—*Tirpentwys Coal* comes within the limits for volatile content for a good coal-dust; *Treharris Coal* has a volatile content considerably below the minimum for a good coal-dust, and *Anthracite*, with its very low volatile content, was only carried through part of the series—two only of these tests are given, as no comparative results were obtained with further tests. Anthracite was used only to prove that the volatile content is one of the essential characteristics of a good coal-dust.

Percentages of coal-dust to red sand were chosen to give low, medium and high mixtures for experimental comparison. The gas given off when a mould was cast was judged by the amount coming away as a blue flame at the box joint. "*Shiny silver-grey*" refers to that very bright silvery appearance of the skin when too much good coal-dust has been used, leaving a carbon-flake deposit on the casting.

The appearance and changed condition of the facing sand, after the casting has been removed from the mould, is very interesting, and merits a detailed description and analysis. The record of the tests shown in Table I prove very conclusively the greater efficiency of the fine grists and the high volatile coal.

Test No. 1, with only 5 per cent. of high-volatile coal-dust added, gave a passable skin, whereas *Test No.* 10, with the same percentage of lower-volatile coal-dust, was very poor. *Test No.* 2 had rather too much coal-dust for a perfect blue skin, whereas the results shown for *Test No.* 3 proved that for coal-dust of this volatile content and fineness the percentage of coal-dust to sand is very excessive. The comparison of the casting skin of the remaining tests is so obvious as to require no emphasis.

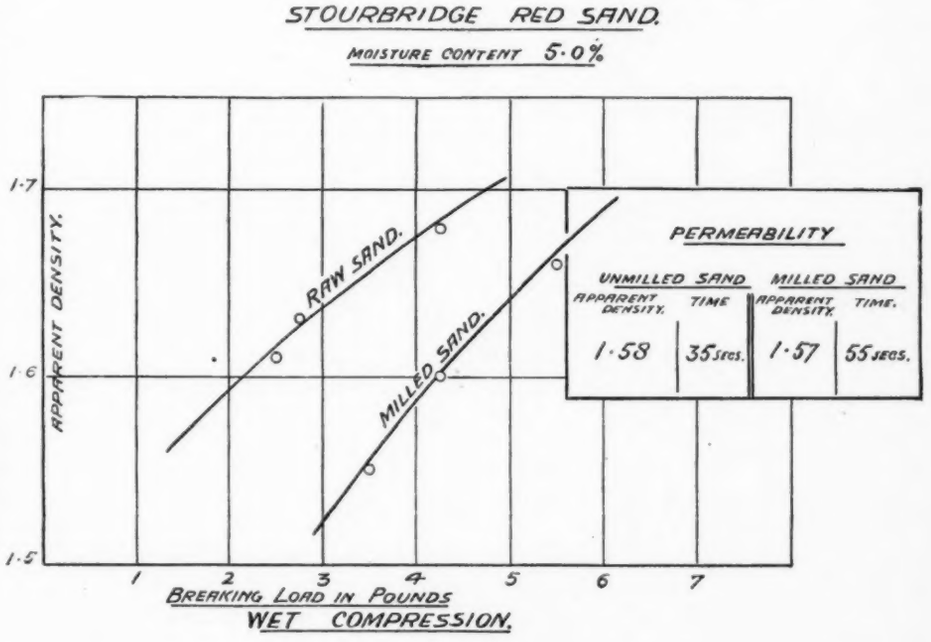


FIG. 1.

Experiments.

The first experiments were made with small castings, weighing 6 lbs. each, from the pattern of a soleplate 5 in. × 7 in. × ⅝ in. thick (Fig. 2). The facing-sand contained 5, 15 and 30 per cent. of coal-dust, respectively. Three moulds of each grist enumerated above (1, 2 and 3) were made and cast separately.

Experiments with Heavy Castings.

The experiments just described having been carried out on small castings, weighing only a few pounds, it was decided to carry out similar tests on castings of thicker section, and the following type of casting, and method of testing, was chosen:—A solid cylindrical casting, 11½ in.

TABLE I.—*Coal-Dust Tests on Small Soleplates.*

Stourbridge Red Sand, Unmilled and Dried, used in all Tests. Water added, 5 per cent.

Name of coal.	Analysis.	Grist.	Mixture of facing sand. C.D. to sand.	Test No.	Gas given off when cast.	Colour of casting skin.	Quality of casting skin.	Carbon flake deposit on skin.	Appearance of skin sand from mould.	Appearance immediately behind skin sand.	Amount of top.	Coking bottom.	Appearance of skin sand under magnification.	Appearance of sand immediately behind skin sand, under magnification.
			Per cent.											
TIRPENTWYS	Volatile, 30.6 per cent.	40	5	1	Very slight	Dull blue ..	Fair after wire-brushing	Nil	Slight carbon coating	Loose black grains	Nil	Nil	Slight coating of carbon, shiny black grains	Dull black, slightly matted sand and coal.
			15	2	Slight flame at joint	Blue centre, silver-grey outer edge	Good, very little brushing required	Slight carbon flakes. Bottom face	Silver-grey coked, shiny carbon coated	Grains matted, dull black	$\frac{1}{16}$ in.	$\frac{1}{8}$ in.	Bright silver grains, carbon covered	Shiny grains of dull black.
			30	3	As above ..	Shiny silver-grey	Smooth but slightly mapped	Large amount ..	Coked bright silver grey	Well matted but not coked	$\frac{5}{16}$ in.	$\frac{1}{4}$ in.	As above	As above.
	Ash, 10.4 per cent.	28	5	4	Very slight	Dull blue-black	Poor, rough after wire-brushing	Nil	Slight carbon coat, matted grains	Loose dark grains	Nil	Nil	Shiny black grains and small beads of coke	Matted sand and coal grains.
			15	5	As above ..	Dull silvery-grey	Fair, but slightly pockmarked when brushed	Very slight	Silvery-grey	Dark matted grains	$\frac{1}{32}$ in.	$\frac{1}{16}$ in.	Silvery-coated grains of carbon and coke	As above.
			30	6	Moderate flame at joint	Bright silver-grey	Clean, but slightly pockmarked all over	Large amount of carbon flake	Coked bright silver-grey	Well matted, $\frac{1}{2}$ in. thick	$\frac{3}{16}$ in.	$\frac{1}{8}$ in.	Bright silver grains, carbon covered	Heavy masses of matted grains.
	Carbon, by difference, 59.0 per cent.	12	5	7	Very slight	Poor, dull blue-black	Poor, rough, pockmarked after brushing	Nil	Matted grains, carbon coated	Loose dark grains	Nil	Nil	Matted dark grains and coked beads of coal	As above, but less matted.
			15	8	Slight ..	Dull silver-grey	Poor, pockmarked when brushed	Very slight carbon flakes	Silvery-grey	Dark matted grains	$\frac{1}{32}$ in.	$\frac{1}{32}$ in.	Silvery-coated grains of carbon-covered sand	Dull matted grains of sand and coal.
			30	9	Medium flame	Silvery-grey	Badly pockmarked	Slight amount of carbon flakes	Silvery-grey	As above ..	$\frac{3}{32}$ in.	$\frac{3}{32}$ in.	Silver carbon covered grains	Large lumps of sand and coal, all matted.
TREHARRIS	Volatile, 12.3 per cent.	40	5	10	Very slight	Rough grey	Very poor. Sand burnt on	Nil	No carbon coating clear silica grains	No carbon coating, clear silica grains	Nil	Nil	Clear silica grains ..	Clear silica grains.
			15	11	As above ..	Dull blue-black	Fair, after good wire-brushing	Nil	Dark grains slightly matted	Loose dark grains	Nil	Nil	Some grains black smoked, some showing dull red	Same, but more untouched grains dull red.
			30	12	Slight ..	Dull blue ..	Fairly smooth after good brushing	Nil	As above	As above ..	Nil	Nil	Grains of sand are dark smoked	Similar, but some untouched grains.
	Ash, 16.10 per cent.	28	5	13	Nil	Very rough and grey	Slight scab at centre. Very poor. Burnt on	Nil	Grey silica grains, dark specks of burnt coal	Grey silica grains, specks of coal	Nil	Nil	Clear silica grains ..	Clear silica grains.
			15	14	Very very slight	Dull black	Rather poor	Nil	Dark grains, very slightly matted	Loose dark grains	Nil	Nil	Some dark grains, some dull red	Same, but more untouched red grains.
			30	15	Slight ..	Blue-black, sand stuck to casting	Very poor. Rough, covered with small pockmarks	Nil	Shiny black grains, no coking bonding	Dark lumps of matted sand and coal grains, dull black	Nil	Nil	Shiny grains of sand, carbon covered, and small beads of coke	Matted lumps of sand and coal, partly fused.
	Carbon, by difference, 71.60 per cent.	12	5	16	Nil	Very rough and grey	Very bad. Rough and deeply pockmarked	Nil	Grey, with large grey spots due to coal	Same	Nil	Nil	Clear silica grains and half-coked grains of coal	Same.
			15	17	Very very slight	Bad, greyish-blue	As above	Nil	Dull smoky black ..	Dull black grains and dirty red grains	Nil	Nil	Some dark grains matted and some dull red	Same, but more half-smoked red grains.
			30	18	Fair amount	Bad, dirty blue-grey	Extremely bad. Rough, very deep pockmarks	Nil	Rough matted lumps of coked sand and coal slightly metallic	Rough matted dull grains	Nil	Nil	Fine grains have metallic coating	Dark matted lumps of partly coked coal and sand.
ANTHRACITE	Volatile, 6.6 per cent. Ash, 9.70 per cent. Carbon, by difference, 83.7 per cent.	40	5	19	Nil	Rough and grey	Very poor. Sand burnt on	Nil	Grey silica grains specked with grains of coal unchanged	Same	Nil	Nil	Clear transparent silica grains and specks of unchanged coal	Same.
			30	20	Nil	Rough, darker grey	Very poor. Sand and coal burnt in like emery cloth	Nil	Same as above; more coal specks	Same	Nil	Nil	As above; more coal grains	Same.

TABLE II.—*Coal-Dust Tests on Heavy Castings.*

Stourbridge Red Sand, Unmilled and Dried, used in all Tests. Water added, 5 per cent.

Test-piece.	Quarter-section.	Grist.	Percentage of coal-dust in sand.	Colour of skin.	Quality of skin.	Carbon flake deposit on skin.	Appearance of skin sand.	Appearance immediately behind skin sand.	Skin sand magnified.	Behind skin sand magnified.
A Open sand mould	Z	40	30	Bright blue. Top portion slightly silvery	Smooth, mapped. Fins of mapping $\frac{3}{16}$ in. high	Very slight in upper portion of casting	Coked silvery grey, $\frac{3}{8}$ in. deep	Dark grains matted together, $\frac{1}{2}$ to $\frac{3}{4}$ in. deep	Bright silvery grains, carbon coated, well-coked coal grains	Grains of sand, black-carbon coated. Partly-coked coal grains.
	Y	40	15	Deep blue	Smooth good skin, no mapping	Nil ..	Coked bluish-grey, $\frac{3}{16}$ in. deep	Dark grains matted together, $\frac{1}{2}$ to $\frac{5}{8}$ in. deep	As above	As above.
	X	40	10	Dull grey with some dark blue patches	Rough, sand slightly burnt on	Nil ..	No coking. Sand and coal grains matted, $\frac{1}{2}$ in. deep..		Dull black smoked grains of sand and partly-coked coal grains.	
	W	40	5	Light grey	Very rough, sand fritted and burnt in. No skin	Nil ..	No coking or matting, sand grains clean white silica, very slight carbon coat on a few grains		Clear silica grains, with very few black grains, comprising coated grains of sand and specks of coke and coal.	
B Closed mould	V	40	30	Silvery, with a few patches of blue	Smooth, very badly mapped, fins of mapping $\frac{1}{8}$ in. high	Considerable in upper half	Coked silvery-grey, about $\frac{3}{8}$ in. deep	Shiny dark grains matted together, $\frac{1}{2}$ to $\frac{3}{4}$ in. deep	Bright silvery grains, carbon coated, and well-coked coal grains	Sand grains with shiny black carbon. Partly-coked coal grains.
	U	40	15	Bright blue	Very good smooth skin. No mapping	Nil ..	Coked bluish-grey, $\frac{3}{16}$ in. deep	Dark grains matted together, $\frac{1}{2}$ to $\frac{5}{8}$ in. deep	As above	As above.
	T	40	10	Dark blue	Fairly good after wire brushing	Nil ..	No coking. Sand and grains of coal slightly matted		All sand grains slightly carbon coated. Coal grains partly coked.	
	S	40	5	Light grey	Very rough, sand burnt in. No skin	Nil ..	Very slight carbon coating on a few skin grains	Clear white silica, with few dark specks of coal. No matting	Clear silica grains, with a few black grains comprising coated grains of sand, and specks of coke and coal, approximately 10 per cent. black.	
C	R	28	30	Dull blue	Poor quality, shallow pockmarks. Slightly ratched bottom	Nil ..	Slight coking, bluish-grey, about $\frac{1}{8}$ in. deep	Shiny dark grains, matted	Mixture of bright silver grains and shiny black. Approx. 50 per cent. of each. Large pieces of coked coal	Black carbon-coated grains, specks of coal and partly-coked coal.
	Q	28	15	Dull blue top portion. Dark dirty grey lower half	Poor. Pockmarks upper part. Slightly ratched bottom half	Nil ..	No coking, very little matting of grains. Dark grey	Dark grains of sand, carbon covered	Mixture of clear silica grains, with black carbon-coated grains. Approx. 25 per cent. of black grains. Large coked grains	As above.
	P	28	10	Dull dirty grey, slightly better skin upper half	Very poor. Sand burnt on lower part. Slightly better skin upper half	Nil ..	No coking. Sand grains matted with partly-coked coal	No coking. Sand grains matted with partly-coked coal	Mostly clear silica grains. Approx. 10 per cent. black grains, and a few coked grains	As above.
	O	28	5	Light grey	Very rough. Sand burnt in. No skin	Nil ..	No coking or matting. Clean silica grains and some black grains	No coking or matting. Clean silica grains and some black grains	Clean silica grains with very few dark grains, comprising coated grains of sand, specks of coke and coal. Approx. 5 per cent. black.	
D	N	12	30	Dull blue	Very poor. Very deep pockmarks and badly ratched	Nil ..	Very slight coking, $\frac{1}{16}$ in. deep. Bluish-grey large cokes bedded in sand	Coarse grains of coal bedded in carbon-coated sand grains	Few silvery grains, but mostly shiny black, with large pieces of coked coal	Black carbon-coated grains and specks of coal partly coked.
	M	12	15	Dull blue	Fair. Shallow pockmarks and slightly ratched	Nil ..	No coking of sand, slightly matted	Dark grains of sand carbon covered. Slightly matted	Mixture of silica grains and carbon-coated grains with large coked coal. 75 per cent. coated grains	Mixture of silica grains with black carbon grains and partly-coked coal, 75 per cent. coated.
	L	12	10	Dull blue	Fairly good. Best skin on casting. No pockmarks or ratching	Nil ..	No coking or matting. Grey silica sand with a few black specks	As above	Clear silica grains with a few dark grains and large specks of coked coal, 10 per cent. coated	Mixture of silica grains with black carbon grains and partly-coked coal, 50 per cent. coated.
	K	12	5	Grey, but slightly blue on upper half	Very poor. Sand burnt on, but slight sign of skin near top. No pockmarks or ratching	Nil ..	As above	As above	Clear silica grains with a few black grains, comprising coated grains of sand and specks of coke and coal. Approx. 50 per cent. black.	

dia. x 10¾ in. long, was made (see Figs. 3, 4 and 5).

The pattern was faced with four different mixtures of red sand and coal-dust, each covering a quarter of the circumference to the full depth of the mould. This ensured the same mixture and temperature of iron for each set of facing-sand mixtures. The moulds were all bottom-poured, the in-gates being placed about 1½ in. up from the bottom. Four castings were made, one mould (Fig. 2) cast open and three moulds closed. Tirpentwys coal-dust was used in all these tests, varying only in fineness and in percentage mixtures with sand.

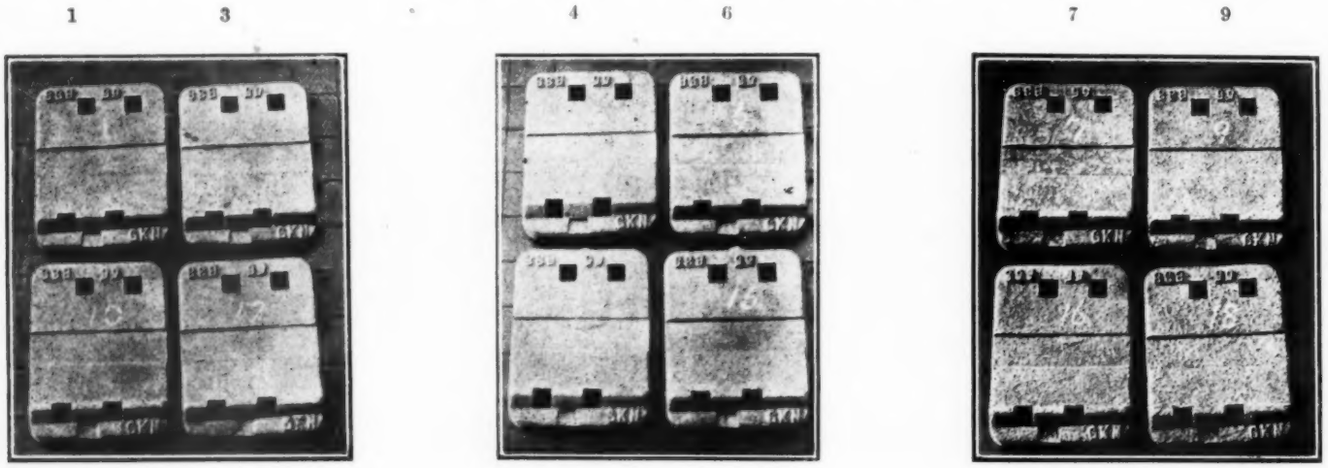
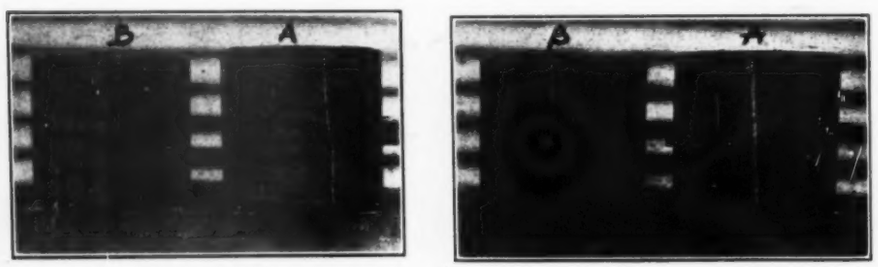


Fig. 2.—Sole-plates.

The results of these experiments are given in Table II.

Comparing "A" (Fig. 3—mould cast open) with "B" (Fig. 3—mould cast closed), the effect of the coal-dust in each section is more pronounced in the latter than in the former. Is the reason for this due to the fact that smoke (from the coal) burnt in front of the rising metal in the open mould; whereas, in the closed mould, the smoke could not burn owing to the absence of free air, and was able thoroughly to coat the face of the mould with carbon deposit. This would explain why the fins on Section V are deeper and more pronounced than on Section Z (Fig. 3). The castings shown in Figs. 4 and 5 were made in closed moulds. They show clearly the inferior results obtained with coarse grists from the same coal-dust.

A noticeable feature of these two series is the pockmarks and ratching which occur with the addition of 30 per cent. and 15 per cent. coal-dust, and do not occur in the 10 per cent. and 5 per cent. mixtures. This is due to the increased percentage of coal-dust in the mould skin, which, when transformed by the action of the hot metal to coke, swells and creates pressure throughout the mould face. Some of the swelling coke, following the line of least resistance, forces itself into the relatively soft, just-solidifying skin of the casting. With a lower percentage of coal-dust these coking-coal grains have more freedom to expand amongst the surrounding sand grains, therefore "pockmarks," "ratching" and "mapping" can be accounted for.



Sections V—S and Z—W. Sections T—U and X—Y.

Fig. 3.—Solid Cylinders.

Pockmarks.

These unsightly defects on the skin of the casting refer to small pits which can be seen in N and R in the upper half of Figs. 5 and 4 respectively and also on sole-plates Nos. 7, 9, 16 and 18 (Fig. 2). They are directly due to coarse coal-dust. When the molten iron covers these grains of coal, they at once give off their volatile matter, and swell as they become coked. Being comparatively large, this swelling is considerable in the individual grains. A portion expands into the soft, just-solidifying skin of the casting and causes this unsightly indentation, or pockmark.

Ratching.

When this swollen piece of coke punctures the thin skin of metal, the liquid metal bleeds through and becomes mixed with the coke, causing those small eruptions on the casting-skin which require filing, or chipping, to remove. Examples can be seen in the lower part of N in Fig. 5, and in Table II they are termed "ratching."

Mapping.

Mapping can be clearly seen in sections Z and V of Fig. 3. The direct cause of this defect is due to an excessive amount of fine, high-volatile coal-dust in the facing-sand. When the molten iron is poured into the mould the fine specks of coal, thoroughly intermixed with the grains of sand, give off their volatile-matter and change from specks of coal to small beads of coke. This change, which takes place instantly, causes the specks of coal to swell to more than twice their previous size. This combined action considerably expands the skin of the mould, which buckles inwards, and cracks. The fluid portions of the casting enter into the fissures and form fins on the face of the casting.

Experiments with Mica-Window Moulds.

A desire to observe what actually happens inside a closed-mould during casting led to the adoption of a special mould with a mica window. Details are shown in Fig. 6 and the sketch in Fig. 7. The pattern, with strip of mica, is shown at A. This was rammed up in the usual way in a three-parted box, with the mica in position and opposite the opening in the middle part. Before the pattern was withdrawn the intervening sand between the mica and the slot in the box was cut away, care being taken not to expose the extreme edges of the mica. The in-gate was cut in at the bottom joint, shown in casting at B in Fig. 6. The mould was cast on a low stool to facilitate observation and photographing.

When molten iron was poured into the moulds made with coal-dust facing-sand, smoke immediately began to rise up the sides of the mould. The thickness of this smoke varies with the amount of coal-dust in the sand, and its volatile content. The top of the rising metal has the form of a meniscus, the convex face uppermost as shown in diagram Fig. 8. The metal rises with a rolling action against the sides of the mould, due to the friction of the sand face. There appears to be a clear space, about ⅛ in. to ¼ in. (which follows the shape of the meniscus) between the top of the rising metal and the smoke. This is due to the intense heat of the molten iron. It required very close observation to see the rising metal trap any of the coal gas. It is certain that this action takes place because the coal specks are giving off their volatile gases and continue for some time after the metal has covered them.

Photographs taken through the mica window are shown in Fig. 9. Owing to the exposure required to take photographs, the meniscus and space between the metal and the smoke, referred to, do not show very clearly. A distinct difference in the volume of smoke, due to the quantity and volatile content of coal-dust used, can be seen.

(To be continued.)

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Trade Talk.

ON JUNE 15 the staff and employees of Messrs. Paul & MacLachlan, Limited, ironfounders, of Denny, held thier annual outing to Aberdeen.

BIRCHGROVE STEELWORKS, Llansamlet, Swansea, have been sold by auction for £11,307, including £4,707 valuation of stock, to Colonel William Jones, of Ammanford.

THE SCHEME of arrangement between Sheffield Steel Products, Limited, and its shareholders and debenture holders has been approved by the various classes of share and security holders.

HERRMANN & SÖHNE, of München, Germany, have appointed Thomas E. Gray & Company, Limited, their sole agents in Great Britain for their well-known core- and mould-drying systems and annealing furnaces.

MESSRS. WEBSTER & COMPANY (SHEFFIELD), LIMITED, announce that their registered office has been transferred to Marriott Wood Brickworks, Millhouses, Sheffield. The telephone number is Beauchief 71071.

AMERICAN and Canadian visitors to the exhibition who witnessed the cupola-ramming demonstrations given by Thomas E. Gray & Company, Limited, have since placed substantial orders with the company for "Silacene."

SINCE THE completion of the kilns at Worksop General Refractories, Limited, have had a number of inquiries for kilns from brick manufacturers, and expect to be working at full pressure in this department during the next six months.

AN EXTRAORDINARY general meeting of the Manganese Bronze and Brass Company, Limited, was held in London last week in order to consider a scheme of arrangement. Steps have been taken to reorganise the capital of the company.

MESSRS. A. HALL & COMPANY, LIMITED, Aberdeen, have launched the harbour service vessel "Erni," which is designed for supplying fresh water and coal to dredgers. The vessel has been built for the James Dredging, Towage and Transport Company, Limited, London.

THE STANTON IRONWORKS COMPANY, LIMITED, state that the rebuilding of their blast-furnace plant has reached such a stage that it has now been possible to dispense with the whole of the old furnaces. Four complete new units out of the five proposed are now in operation.

MESSRS. ALFRED HOLT & COMPANY, Liverpool, have ordered from Messrs. Scotts' Shipbuilding and Engineering Company, Limited, Greenock, a twin-screw passenger and cargo motor-ship, 452 feet long. The propelling machinery will be supplied by Messrs. Burmeister & Wain, Copenhagen.

A RECENT ANNOUNCEMENT in our advertisement columns stated that the new hose clips marketed by Messrs. L. Le Personne & Company, of 99, Cannon Street, London, E.C.4, had been awarded a silver medal by the authorities of the Foire de Paris. This was actually an award of a gold medal.

MESSRS. ARDROSSAN DOCKYARD COMPANY, LIMITED, have launched the single-screw motor-vessel "Henry Stanley," which they have built for the African Steamship Company, Liverpool. The vessel is of the three-deck type, 370 ft. between perpendiculars, with a breadth of 51½ ft. and depth to shelter deck of 33½ ft.

THE TEESIDE CHAMBER OF COMMERCE has received a complaint from the Cargo Fleet Iron Company, Limited, that Middlesbrough is handicapped by higher cargo rates to Australia as compared with those charged from Glasgow. It is stated that the cost of shipment of cargo from Middlesbrough to Melbourne is 5s. 6d. per ton more than the rate from Glasgow. The Chamber referred the matter to its Shipment Committee.

THE BLYTHSWOOD SHIPBUILDING COMPANY, LIMITED, Glasgow, have obtained from the Union Steamship Company, of New Zealand, an order for a single-screw passenger and cargo vessel, 330 feet in length, 45 feet broad and of 12½ knots speed, with special accommodation for fruit and other cargoes. Triple-expansion reciprocating engines will be supplied by Messrs. D. & W. Henderson & Company, Limited, Partick, Glasgow.

MESSRS. SCOTTS' SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, Greenock, have just launched the single-screw cargo steamer "Earlspark," which they have built to the order of the Denholm Line Steamers, Limited, Glasgow. The dimensions of the vessel are length 405 ft., breadth 53 ft., and depth 31 ft., with a deadweight carrying capacity of 8,000 tons. Propelling machinery will consist of one set of triple-expansion engines.

THE INSTITUTION OF GAS ENGINEERS has been granted a Royal Charter. The Institution attained its jubilee in 1913. It was first formed as an unincorporated association under the name of The British Association of Gas Managers, having for its objects "the encouragement and advancement of all matters connected with gas engineering, manufacturing and finance and the exchange of information and ideas among its members." In 1902 the Institution in its present form came into being.

A MEETING OF representatives of some of the leading nickel-producing companies of the world has been held in Paris. During the discussions it was pointed out that the development of the nickel industry has assumed such proportions that production does not keep pace with the demand. The representative of the International Nickel Company, who presided over the conference, proposed a resolution that the present competition should be replaced by co-operation, in the interest both of producer and consumer.

BIRMINGHAM ELECTRIC FURNACES, LIMITED, of 55, George Street, Parade, Birmingham, inform us that they have received from Messrs. Morris Commercial Cars, Limited, an order for an electric box-type carburising furnace, complete with "Birlec" four-arm charging machine, turntable and loading trolleys. It is thought that this furnace, which has a usable hearth, 9 ft. long by 5 ft. wide, and a maximum rating of approximately 185 kw. at 440 volts, three-phase, will be the largest electric carburising furnace in this country.

YORKSHIRE AMALGAMATED PRODUCTS, LIMITED, of Doncaster, have just placed with General Refractories, Limited, of Sheffield and Worksop, an order for a new kiln for their Bawtry Silica Brickworks. The kiln will be the largest so far built at Bawtry, and will hold approximately 30,000 silica bricks. It will be of the same type as the four recently erected by the same firm at the Worksop brickworks, and will be fully insulated against heat losses (crown, walls, sole and flues), and will be of the most modern form of construction in every way.

AT A MASS MEETING of the employees of Messrs. William Beardmore & Company, Limited, at Mossend Steelworks, a resolution was drawn up and signed with the object of securing a resumption of the works. The resolution asked that a share of the work going on should be allocated to Mossend. The petitioners stated that in the past three years only about 44 weeks' employment had been obtained, and also drew attention to the hardships of many who had been cut off the pay-list at the Labour Exchange. The resolution, which has 500 signatures, has been forwarded to the Ministry of Labour.

DESPITE A GENERALLY unfavourable condition in the international pig-iron market, the only blast-furnace works in Holland—the N. V. Koninklijke Nederlandsche Hoogovens en Staalfabrieken, with plant at Ijmuiden—reported that it was able by the end of the fiscal year (March 31, 1929) to pay up the arrears of dividend on its preferred shares. This was accomplished through the marketing of its entire production of 258,224 metric tons of pig-iron, a figure which compares favourably with 203,692 tons in 1927. Prospects for an even better year in 1929 seem bright. A third furnace may be added during the current year to the two already in operation.

AN EMERGENCY MEETING of the Executive Council of the Federated Associations of Scrap Iron, Steel, Metals and Machinery Merchants of Great Britain was held in Birmingham on Thursday, June 13, for the purpose of discussing the attitude to be adopted by the Federation in connection with the committee recently set up by the President of the Board of Trade to inquire into the question of the supply of scrap for the manufacture of steel within the United Kingdom. It was resolved "that the Federation was in favour of maintaining free trade as regards its industry, and that there should be no restrictions of any nature in respect of the scrap-metal merchanting business."

IN ORDER to increase the efficiency of its work, by avoiding overlapping and duplication of activities, the Bureau of Information on Nickel, Limited, is joining forces with the Research and Development Department of the Mond Nickel Company, Limited. This arrangement will provide greater possibilities of service on the part of each organisation, to British industry as a whole, and to all those who are interested in the use of nickel and its alloys. The title and address of the Bureau is now The Bureau of Information on Nickel of the Mond Nickel Company, Limited, Imperial Chemical House, Millbank, S.W.1; telephone, Victoria 4444. The management of the Bureau will continue to be in the hands of Mr. A. C. Sturney.

Contracts Open.

Coventry, July 8.—1,300 tons of lap-welded steel socket and spigot pipes of 28-in., 21-in. and 18-in. dia., and cast-iron pipes, valves and specials, for the Corporation. Sir A. Binnie, Son & Deacon, 30, Buckingham Gate, Westminster, S.W.1. (Fee £5, returnable.)

Enniskillen, July 6.—Iron fire-escape, for the Fermanagh County Hospital, Enniskillen. Mr. J. Donnelly, Enniskillen.

Johannesburg, August 1.—One 10-ton electrically-driven overhead travelling crane, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 8,105.)

Portrush, Ireland, July 1.—260-b.h.p. cold-starting oil engine, direct coupled to one 140-kw. dynamo balancer, together with one auxiliary motor-driven air compressor, for the Urban District Council. The Council Offices. (Fee 10s., non-returnable.)

St. Osyth, Essex, July 1.—2,400 yds. of 3-in. and 4-in. dia. cast-iron water mains, for the Tendring Rural District Council. Mr. S. Francis, water engineer, Station Road, Clacton-on-Sea.

Wellington, N.Z., August 5.—Pumping sets, comprising motor, high-lift pump and low-lift pump mounted on a bedplate, for the Hamilton Borough Council. The Department of Overseas Trade. (Reference A.X. 8,086.)

Personal.

MR. J. GRAY and Mr. H. P. Harland have been appointed to the board of Messrs. Harland & Wolff, Limited.

Wills.

HARRIS, F. W., of The Priory, Church Road, Moseley, Birmingham, chairman of F. W. Harris (Birmingham), Limited, metal merchants, Hurst Street, Birmingham £83,596

HOLMAN, F., M.I.M.E. (87), of North Parade, Penzance, engineer and ironfounder, of N. Holman & Sons, Limited, agricultural implement makers £15,037

Obituary.

MR. ROBERT HILDICK, edge-tool manufacturer, of Sheffield, died on Friday, June 14, aged 76.

MR. WILLIAM WESSON, founder of the firm of W. Wesson & Company, Limited, Victoria Iron and Steel Works, Wednesbury, died on June 18, aged 84.

MR. SYDNEY WILSON, who was for many years spring manager at the Atlas Works, Sheffield, of Messrs. John Brown & Company, Limited, died recently, aged 59.

THE DEATH occurred in Larbert, on June 16, of Mr. William Wilson, after a short illness. Mr. Wilson joined Messrs. Robert Taylor & Company when they opened their Muirhall Foundry, Larbert, about nine years ago.

Reports and Dividends.

Mirrlees, Bickerton & Day, Limited.—Net profit, £31,895; brought in, £5,828; dividend of 7 per cent.; carried forward, £8,504.

Butterley Company, Limited.—Net profit, £59,104; brought in, £33,213; dividend of 6d. per share, tax free; carried forward, £47,317.

Ransomes, Sims & Jefferies, Limited.—Net profit, £21,111; brought in, £52,822; dividend of 2½ per cent.; carried forward, £50,434.

Hick, Hargreaves & Company, Limited.—Profit, £11,446; brought in, £474; dividend at rate of 2½ per cent., less tax; carried forward, £7,120.

Manganese Bronze and Brass Company, Limited.—Trading profit, £21,384; debit balance brought forward, £11,909; credit balance on profit and loss account, £208.

James Keith & Blackman Company, Limited.—Net profit, £49,740; dividend on the ordinary shares of 15 per cent., less tax, £24,000; to reserve account, £12,000; carried forward, £13,740.

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STEELFOUNDRY SAND

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In the preparation of Yorkshire Sand, the makers are users of British Steel Castings in various forms. French and Belgian Sand Quarries are NOT.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The prevailing scarcity of pig-iron in the North-East area, to which comment has previously been directed in these reports, is rapidly approaching serious dimensions, and, with an ever-growing demand for this staple product, Cleveland ironmasters are now faced with one of the most difficult problems in the experience of the industry. In similar circumstances previously, when demand outran production, it was comparatively easy for makers to increase outputs by employing additional furnaces, but to-day the excessive cost of fuel and raw material no longer permits such a simple solution of the difficulty, with the result that the Cleveland market is now threatened with determined competition by some of the leading Midland producers. In the face of more urgent needs for foundry pig at home, there is also little possibility of expansion of export trade, and consequently shipments from Tees ports for June show a heavy decrease, while imports of this quality of material are practically insignificant. Market operations in this district are now almost solely confined to meeting the requirements of the makers' regular customers, contracts being mostly negotiated with the proviso that delivery is conditional, if and when the iron is available. Meanwhile, nominal quotations rule as follow:—No. 1 Cleveland foundry iron, 75s. per ton; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; No. 4 forge, 71s. per ton.

Both at home and abroad the demand for East-Coast hematite continues active, and already a substantial expansion of output is either provided or in course of preparation on Tees-side. This movement on the part of producers tends to retard advances in price, but it has to be remembered that production costs are increasing, and as a result a rise of 6d. per ton is to be recorded this week. Orders are now being placed on the basis of 74s. 6d. per ton for mixed numbers and 75s. for No. 1 quality. On the North-West Coast, Bessemer mixed numbers are still quoted at 75s. per ton at works.

LANCASHIRE.—Consumption of foundry pig in this area continues on a steadily expanding scale, with the result that it is becoming more difficult to place contracts for forward delivery on the favourable terms previously available. Prices, however, so far, are unchanged, quotations ruling at about 72s. for Derbyshire No. 3, with Staffordshire at 73s. and Scottish at 92s., all per ton delivered locally.

THE MIDLANDS.—The increased activity of buying interest in foundry pig recently reported at Birmingham is so far maintained, and a fairly substantial tonnage is going into local consumption. At present there is no official alteration in the zone prices, which are 73s. 6d. for Derbyshire No. 3, 74s. 6d. for North Staffordshire No. 3, and 70s. for Northants No. 3, delivered local stations. Certain furnaces which are well booked, however, are not prepared to take new business at these levels, and are demanding up to 2s. 6d. per ton extra.

SCOTLAND.—The market for Scotch pig-iron continues depressed, the amount of business passing being very small, and there are no signs of any immediate improvement. Prices, however, remain firm on the basis of the official minimum of 74s. 6d. for No. 3 Scotch foundry at furnaces.

Finished Iron.

At Birmingham it is reported in one or two quarters that there has been some improvement in demand for crown and Staffordshire marked bars, but the position of nut and bolt iron is without change, and it is difficult to see that there can be any alteration in the conditions governing this class of iron while Continental material can be obtained at such cheap rates. Good crown iron is quoted at between £10 and £10 5s. per ton, but other "crowns" are quoted at anything from £9 10s. to £10 per ton. Marked bars are unchanged at £12 at makers' works, and the makers of this class of bar are fairly busy.

Steel.

Production of steel and semis in the Sheffield area continues on a fairly satisfactory scale. Special steels are in heavy demand, and there is a better inquiry for crucible quality. Makers of cold-rolled strip are busy, and plants for making railway material are better employed than for some time past. Quotations rule as follow:—Siemens acid billets, £9 10s.; basic billets, soft, £7; semi-hard, £7 12s. 6d.; medium, £8 2s. 6d.; hard, £9 2s. 6d. to £9 12s. 6d.; basic wire rods, soft, £8 10s.; medium hard, £9 10s. to £10; hard, £10 15s.; acid, £12 5s. to £12 10s. In the tinplate market quotations range at around 18s. 3d. to 18s. 6d. basis for coke qualities, net cash, f.o.b. Welsh ports. The demand for tinplates fails to show any substantial improvement, but the demand is rather better.

Scrap.

With the prevailing scarcity of pig-iron, there is necessarily a more active demand for scrap suitable for foundry purposes, and on the North-East Coast good ordinary cast-iron material realises 65s. per ton, with machinery quality priced at 67s. 6d. per ton, delivered works. In the Midlands the demand for heavy cast-iron scrap is still maintained at 70s. to 72s. 6d. and 57s. 6d. for light cast-iron scrap. In Scotland ordinary cast-iron scrap is quoted at around 62s. 6d., machinery quality 70s. to 71s. 6d., old cast-iron railway chairs 66s. 6d., and light cast iron at 60s. to 61s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—With a generally restricted demand, due principally to seasonal causes, the market for warrant copper has developed a weaker tendency, with dealings on an irregular scale. In spite of the fact that reduced production and other restrictive measures are now in force, the great revival of buying interest which, it was anticipated, would appear as a result has not as yet manifested itself, and at the moment it would appear unlikely that any such new buying wave will materialise in the near future.

Closing quotations are :—

Cash.—Thursday, £72 15s. to £72 16s. 3d.; Friday, £73 3s. 9d. to £73 5s.; Monday, £73 17s. 6d. to £74; Tuesday, £74 8s. 9d. to £74 10s.; Wednesday, £73 18s. 9d. to £74.

Three Months.—Thursday, £73 to £73 1s. 3d.; Friday, £73 5s. to £73 6s. 3d.; Monday, £73 11s. 3d. to £73 12s. 6d.; Tuesday, £73 15s. to £73 16s. 3d.; Wednesday, £73 8s. 9d. to £73 10s.

Tin.—Speculative interest in standard tin has been an outstanding feature of recent market operations, and so far has resulted in advanced values, though whether such conditions will develop permanent strength of quotations is left an open question. The latest scheme in furtherance of this object, it would appear, is the formation of a company to take over the holdings of the group and to continue their policy of providing support from time to time by lifting surplus stocks from the market. As a result, a strong lack of confidence pervades the market, as buyers fully realise the dangerous position which is brought about when large quantities of metal are overhanging the market.

Official closing prices :—

Cash.—Thursday, £202 to £202 5s.; Friday, £202 to £202 5s.; Monday, £201 10s. to £201 15s.; Tuesday, £200 10s. to £200 15s.; Wednesday, £200 17s. 6d. to £201 17s. 6d.

Three Months. — Thursday, £205 10s. to £205 12s. 6d.; Friday, £205 10s. to £205 12s. 6d.; Monday, £205 2s. 6d. to £205 5s.; Tuesday, £203 17s. 6d. to £204 2s. 6d.; Wednesday, £204 7s. 6d. to £204 10s.

Spelter.—The lack of definite information regarding the outcome of the meetings of the Cartel has had a depressing effect on the market. Demand from consumers is at unsatisfactory levels, and as a result prices have had an easier tendency during the past week.

Daily quotations are :—

Ordinary. — Thursday, £26 2s. 6d.; Friday, £26 2s. 6d.; Monday, £26 2s. 6d.; Tuesday, £26 2s. 6d.; Wednesday, £26 3s. 9d.

Lead.—The undertone of the market for soft foreign pig continues firm, and values have shown only very small fluctuations of late. Recent arrivals have not been so plentiful, with the result that early lead is in demand, but it is anticipated that considerable quantities will be landed during the next six weeks. Consumptive demand is on a moderate scale, and all present indications point to the maintenance of the existing conditions in the lead market.

Prices have been :—

Soft Foreign Prompt.—Thursday, £24; Friday, £23 17s. 6d.; Monday, £23 17s. 6d.; Tuesday, £23 17s. 6d.; Wednesday, £23 15s.

Students' Corner

Q.—For foundry sand, what is meant by porosity and permeability?

A.—All moulding sands and core sands should be permeable, *id est*, gases and air should pass freely between the sand grains. Briefly, porosity represents cavities, and if "permeable" these cavities have passages between them.

Q.—Sand and loam cores assume various shapes and forms, which cores require the most care in venting?

A.—Generally speaking, a green-sand core requires more care when venting than does a dry-sand core, because of the moisture. Small cores require more care than large ones, because there is less porous material for the expanded air to pass into. Bottle-neck cores; chamber cores; port cores for cylinders, etc., whether large or small require more care when venting than plain round or square cores.

The more closely the core is encircled with molten metal the greater is the amount of care needed. With cores of this description, provision must be made to bring away the air as the mould is being poured. Air and gases must always pass easily and freely through the vents into the atmosphere. If any storage of expanded air and generated gases is permitted with either core or mould there is always a danger of an explosion either on a small or large scale.

Q.—What is the composition of atmospheric air?

A.—Roughly, air is composed of 79 parts nitrogen and 21 parts oxygen. A cub. ft. of air at 0 deg. C. weighs 0.0807 lb. Air is elastic and expands with heat. The measure of expansion is determined and corresponds to the heat imparted. Each cub. ft. expands 0.00366 cub. ft. for each degree rise in the temperature. Hence, at a pouring temperature of 1,400 deg. C. the air has about five times its original volume. The other gases generated are probably hydrogen methane, etc. A green-sand mould contains, when being poured with molten iron, gases that would supply energy for many types of engines.

Q.—If a mould blows violently from a core, who is to blame—the moulder or coremaker?

A.—Possibly both. One is responsible for making a good core, the other for making adequate provision for the air to escape. Both, or either, may or may not be to blame.

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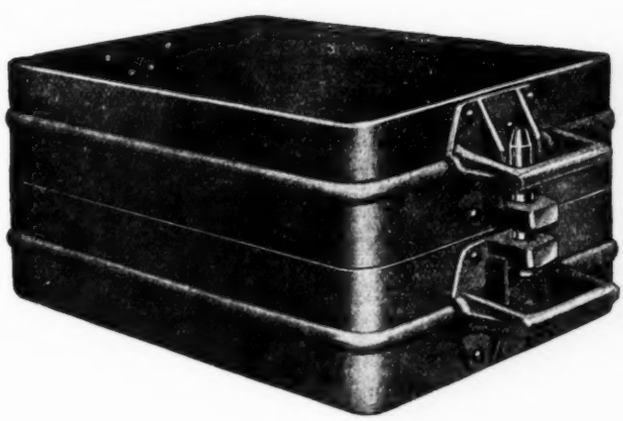

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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	73	18	9
Three months	73	8	9
Electrolytic	83	15	0
Tough	76	10	0
Best selected	76	10	0
Sheets	110	0	0
India	93	0	0
Wire bars	84	12	6
Do. July	84	12	6
Do. Aug.	84	12	6
Ingot bars	84	12	6
H.C. wire rods	86	17	6
Off. av. cash, May	75	2	6
Do. 3 mths., May	73	9	6 6/11
Do., Sttlmnt., May	75	2	4 7/11
Do., Electro, May	84	2	5 7/22
Do., B.S., May	76	19	8 3/4
Aver. spot price, copper, May	75	2	6
Do. wire bars, May	84	10	4 1/11
Solid drawn tubes			15½d.
Brazed tubes			15½d.
Wire			12½d.

BRASS.

Solid drawn tubes	13d.
Brazed tubes	15d.
Rods, drawn	12¼d.
Rods, extd. or rlld.	8¼d.
Sheets to 10 w.g.	11½d.
Wire	11½d.
Rolled metal	10¾d.
Yellow metal rods	8¼d.
Do. 4 × 4 Squares	9d.
Do. 4 × 3 Sheets	9½d.

TIN.

	£	s.	d.
Standard cash	200	17	6
Three months	204	7	6
English	201	15	0
Bars	203	5	0
Straits	204	0	0
Australian	202	10	0
Eastern	207	5	0
Banca	207	10	0
Off. av. cash, May	197	12	8 8/11
Do., 3 mths., May	200	2	11 6/11
Do., Sttlmt., May	197	12	11 8/11
Aver. spot, May	197	12	8 8/11

SPELTER.

	£	s.	d.
Ordinary	26	3	9
Remelted	24	10	0
Hard	21	5	0
Electro 99.9	29	0	0
English	26	10	0
India	23	0	0
Zinc dust (Nom.)	36	0	0
Zinc ashes	9	0	0
Off. aver., May	26	13	4 1/11
Aver., spot, May	26	14	6 8/11

LEAD.

	£	s.	d.
Soft foreign ppt.	23	15	0
English	25	5	0
Off. average, May	23	16	11 13/22
Average spot, May	23	18	11 8/11

ZINC SHEETS, &c.

Zinc sheets, English	35	0	0
Do. V.M. ex whf.	33	7	6
Rods	42	0	0
Boiler plates	31	0	0
Battery plates	32	0	0

ANTIMONY.

Special brands, Eng.	50	5	0
Chinese	33	17	6
Crude	Nominal		

QUICKSILVER.

Quicksilver	22	2	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—			
25%	7	15	0
45/50%	12	0	0
75%	19	10	0
Ferro-vanadium—			
35/50%	13/- lb. Va.		
Ferro-molybdenum—			
70/75% c. free	3/10 lb. Mo.		
Ferro-titanium—			
23/25% carbonless	11d. lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%, c. fr.	2/9 lb.		
Tungsten metal powder—			
98/99%	2/11 lb.		
Ferro-chrome—			
2/4% car.	£32	10	0
4/6% car.	£23	15	0
6/8% car.	£23	2	6
8/10% car.	£22	17	6
Ferro-chrome—			
Max. 2% car.	£34	0	0
Max. 1% car.	£37	12	6
Max. 0·70% car.	£41	12	6
70% carbonless	1/2 lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/4 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/6 lb.		
Ferro-manganese (net)—			
76/80% loose	£13	15	0
76/80% packed	£14	15	0
76/80% export	£14	10	0
Metallic manganese—			
94/96% carbonless	1/6 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0	2	0
Finshed bars, 18% tungsten	£0	2	9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 5/16 in.	1/- lb.
Flats, ¼ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				3	17	6
Bundled steel and shrngs	3	15	0 to	3	17	0
Mixed iron and steel	3	10	0 to	3	12	6
Heavy cast iron	3	3	6 to	3	5	0
Good machinery for foundries				3	10	0
Cleveland—						
Heavy steel				3	5	0
Steel turnings				2	17	6
Cast iron borings				2	17	6
Heavy forge				3	17	6
W.I. piling scrap				3	12	6
Cast-iron scrap	3	6	0 to	3	8	6
Lancashire—						
Cast-iron scrap	3	2	6 to	3	10	0
Hvy. wrought				3	12	6
Steel turnings				2	17	6
Scotland—						
Heavy steel				3	15	0
Cast-iron borings				2	14	0
Wrought-iron piling				3	12	6
Heavy machinery				3	10	0

London—Merchants' buying prices delivered yard.

Copper (clean)	62	0	0
Brass	41	0	0
Lead (less usual draft)	21	0	0
Tea lead	17	10	0
Zinc	17	0	0
New aluminium cuttings	67	0	0
Braziery copper	54	0	0
Gunmetal	53	0	0
Hollow pewter	140	0	0
Shaped black pewter	105	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	75/-
Hematite M/Nos.	74/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	85/-
,, d/d Birm.	91/-
Midlands—	
Staffs. common*	—
,, No. 4 forge*	70/6
,, No. 3 fdry*	74/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	66/-
,, fdry. No. 3*	70/-
Derbyshire forge*	69/6
,, fdry. No. 3*	73/6
,, basic*	—

* d/d Black Country dist.

Scotland—	
Foundry No. 1	77/-
,, No. 3	74/6
Hem. M/Nos.	78/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs. forge	—
,, fdry. No. 3	72/6
E.C. hematite	86/-
W.C. hematite	87/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	72/-
Northants foundry No. 3	—
Dalzell, No 3 (special)	102/6 to 105/-
Summerlee, No. 3	92/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	92/-
Monkland, No. 3	92/-
Shotts, No. 3	92/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.				10	15	0
Nut and bolt iron	9	0	0 to	9	5	0
Hoops	11	0	0 to	11	10	0
Marked bars (Staffs.) f.o.t.				12	0	0
Gas strip	11	0	0 to	11	10	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates	8	12	6 to	8	17	6
Boiler plts.				10	10	0
Chequer plts.				10	12	6
Angles				8	2	6
Tees				9	2	6
Joists				8	2	6
Rounds and squares, 3 in. to 5½ in.				9	2	6
Rounds under 3 in. to ¾ in. (Untested)				8	0	0
				and upwards		
Flats, over 5 in. wide and up				8	7	6
Flats, 5 in. to 1½ in.				7	17	6
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs.)	10	0	0 to	10	10	0
Black sheets, 24g.	10	5	0 to	10	10	0
Galv.cor.shts., 24g.	13	2	6 to	13	15	0
Galv. fencing wire 8g. plain				12	0	0
Billets, soft	6	10	0 to	7	0	0
Billets, hard	7	12	6 to	8	2	6
Sheet bars	6	5	0 to	6	10	0
Tin bars	6	5	0 to	6	10	0

PHOSPHOR BRONZE.

Per lb. basis.

Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6½
Rods	1/5
Tubes	1/9
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	15.00
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	34.00
O.-h. billets	34.00
O.-h. sheet bars	36.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd, No. 13	2.35
Wire nails	2.65
Plain wire	2.80
Barbed wire, galv.	3.30
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	25/- to 30/-
,, furnace	22/- to 25/-
Durham and North.	
,, foundry	17/6 to 19/6
,, furnace	18/-
Midlands, foundry	—
,, furnace	19/- and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box		18/3
,,	28×20 ,,		36/6
,,	20×10 ,,		26/3
,,	18½×14 ,,		18/9
C.W.	20×14 ,,		15/3
,,	28×20 ,,		33/6
,,	20×10 ,,		21/3
,,	18½×14 ,,		16/-
Terneplates	28×20		33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0 to	£7	10	0
Bars, hammered, basis	£17	10	0 to	£18	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	15	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£32	0	0 to	£33	0	0
Faggot steel	£20	0	0 to	£24	0	0
Bars and rods, dead soft, steel	£10	0	0 to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
June	20 ..	72	15	0	dec.	12/6
,,	21 ..	73	3	9	inc.	8/9
,,	24 ..	73	17	6	,,	13/9
,,	25 ..	74	8	9	,,	11/3
,,	26 ..	73	18	9	dec.	10/-

Electrolytic Copper.

		£	s.	d.			
June	20 ..	83	15	0	No	change	
,,	21 ..	83	15	0	,,	,,	,,
,,	24 ..	83	15	0	,,	,,	,,
,,	25 ..	83	15	0	,,	,,	,,
,,	26 ..	83	15	0	,,	,,	,,

Standard Tin (cash).

		£	s.	d.			
June	20 ..	202	0	0	inc.	10/-	
,,	21 ..	202	0	0	No	change	
,,	24 ..	201	10	0	dec.	10/-	
,,	25 ..	200	10	0	,,	20/-	
,,	26 ..	200	17	6	inc.	7/6	

Tin (English ingots).

		£	s.	d.			
June	20 ..	202	15	0	inc.	10/-	
,,	21 ..	203	0	0	,,	5/-	
,,	24 ..	202	5	0	dec.	15/-	
,,	25 ..	201	5	0	,,	20/-	
,,	26 ..	201	15	0	inc.	10/-	

Zinc Sheets (English).

		£	s.	d.			
June	20 ..	35	0	0	No	change	
,,	21 ..	35	0	0	,,	,,	,,
,,	24 ..	35	0	0	,,	,,	,,
,,	25 ..	35	0	0	,,	,,	,,
,,	26 ..	35	0	0	,,	,,	,,

Spelter (ordinary).

		£	s.	d.		
June	20 ..	26	2	6	No	change
,,	21 ..	26	2	6	,,	,,
,,	24 ..	26	2	6	,,	,,
,,	25 ..	26	2	6	,,	,,
,,	26 ..	26	3	9	inc.	1/3

Lead (English).

		£	s.	d.		
June	20 ..	25	5	0	No	change
,,	21 ..	25	5	0	,,	,,
,,	24 ..	25	5	0	,,	,,
,,	25 ..	25	5	0	,,	,,
,,	26 ..	25	5	0	,,	,,

AVERAGE MONTHLY PRICES OF MARKED BARS (SOUTH STAFFS).

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0
1898	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	8 0 0	8 0 0	7 11 8
1899	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	9 0 0	9 0 0	9 10 0	10 0 0	10 0 0	10 0 0	8 3 4
1900	11 0 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 10
1901	9 10 0	9 10 0	9 10 0	9 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 16 8
1902	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 7 6
1903	8 5 0	8 5 0	8 5 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 8 9
1904	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 10
1905	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	8 1 8
1906	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	8 15 10
1907	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0
1908	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 5 10
1909	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1910	8 0 0	8 0 0	8 0 0	8 0 9	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1911	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1912	8 10 0	8 10 0	8 10 0	8 15 0	9 0 0	9 0 0	9 0 0	9 8 0	9 10 0	9 10 0	9 10 0	9 15 0	9 1 6
1913	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	9 10 0	9 10 0	9 4 0	9 0 0	9 0 0	9 13 8
1914	8 12 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 14 4
1915	9 0 0	9 0 0	9 3 0	10 2 0	10 15 0	11 10 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	13 10 0	11 5 0
1916	13 10 0	13 10 0	14 13 0	15 0 0	15 0 0	15 0 0	15 0 0	15 10 0	15 10 0	15 0 0	15 10 0	15 0 0	14 18 7
1917	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1918	15 12 6	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	17 0 0	17 0 0	17 0 0	16 6 3
1919	18 0 0	18 10 0	20 0 0	20 0 0	23 0 0	23 0 0	23 0 0	24 12 0	25 0 0	25 0 0	25 0 0	25 5 0	22 10 7
1920	26 17 6	27 0 0	28 0 0	30 5 0	30 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	31 10 2
1921	31 10 0	30 3 4	27 10 0	27 10 0	27 10 0	24 15 0	21 0 0	20 0 0	20 0 0	17 10 0	17 0 0	16 0 0	23 7 4
1922	16 0 0	14 17 6	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 18 1½
1923	13 10 0	13 10 0	13 16 0	14 7 6	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 5 3½
1924	14 10 0	14 10 0	14 10 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 17 6	14 17 3½
1925	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 0 0	14 13 4
1926	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	—*	14 10 0	14 0 10
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 0 0	13 0 0	12 18 0	13 15 8
1928	12 10 0	12 10 0	12 10 0	12 2 6	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 2 8½
1929	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	—	—	—	—	—	—	—

* No quotation available.

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(A remittance should accompany instructions.)

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FOUNDRY MANAGER or FOREMAN; position desired; practical, technical, and metallurgical knowledge; general and high-class work; 17 years' experience as foreman; good references; moderate salary accepted; M.I.B.F. —Box 246, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

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THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

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FOUNDRY FOR SALE. Mobbs & Company, Limited, Lion Foundry, Northampton. Owing to the continued ill-health of the managing director, who holds over 98 per cent. of the shares and who wishes to retire, this Company has gone into voluntary liquidation, and any offers to purchase the business as a going concern should be made forthwith to the Liquidator, H. FELDON BAKER, Chartered Accountant, Castilian Chambers, Castilian Street, Northampton.

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PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 43 years' experience.—KING'S PATENT AGENCY, LIMITED, 146A, Queen Victoria Street, E.C.4.

MACHINERY.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

12-in. x 50-in. CHURCHILL Universal Grinding Machine.

8-in. x 32-in. Unger Universal Grinding Machine.

No. 60 HEALD Internal Grinding Machine, with planetary head.

BLANCHARD Type Vertical Surface Grinder, magnetic chuck 19½ in. diam.

Two 2-ft. 6-in. GAUGE LOCOMOTIVES (Hudswell, Clarke & Bagnall), 7 in. diam. cylinders; 150/160 lbs. W.P.

Six 2-ft. GAUGE LOCOMOTIVES (Kerr Stuart), two 1922 make, one 1918 make, and three 1915 make, 140 lbs. W.P.

NEW open-top self colour CISTERNS, each about 4 ft. x 4 ft. x 4 ft. deep x 14-gauge thick, with welded seams, capacity about 400 gallons each.

PRESSURE RECEIVERS, 24 ft. x 4 ft. 6 in., hydraulically tested to 300 lbs. per square inch.

18,000 ft. of new 2 in. diam. Screwed and Socketed Piping in lengths of about 18/21 ft., to British Standard Specifications and tested to 270 lbs. hydraulic pressure.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MISCELLANEOUS.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

BRASSFOUNDRY RESIDUES. — **Ashes, Skimmings, Grindings, Dust, bought for best prices; collected by lorry radius 30 miles London, or ex rail beyond.—Communications, KINRIX, 199-201, Warwick Road, London, W.14. 'Phone: Western 0273.**

FOR SALE.—Du-Ram Patent Steel Moulding Boxes, as used by all the leading foundries. Perfect interchangeability and accuracy together with long life. Inquiries solicited. Quick deliveries.—J. W. SADLER & COMPANY, LIMITED, Bartle Lane, Great Horton, Bradford.

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MISCELLANEOUS—*Continued.*

GANISTER, best quality, for cupolas, also for Steel Works.—ASTBURY SILICA COMPANY, "The Brooms," Park Lane, Congleton.

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A. BECK,
MINEOWNER, MATLOCK.

CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. BUCHANAN & COMPANY, Ashfield Road, Altrincham, Cheshire.

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WRITE, WIRE, TELEPHONE, CALL

FOR our 4th Edition Handbook for Foundrymen—The Success of 1929. Foundry Managers, Foremen, Superintendents, Production Managers, Core-makers, Metallurgists, Chemists, Engineers, Iron and Steel Workers, Patternmakers, Melters, Cupola Attendants, Furnace Managers (all classes of Steel-Making), should be in possession of this Handbook (no charge).

WRITE, WIRE, TELEPHONE, CALL.
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Foundry Chemists,
Core Compounds, Plumbagoes, Foundry Fluxes, Parting Powders, etc., etc.
RETORT WORKS, MAPPIN STREET, SHEFFIELD.
Laboratories, including Analytical, Physical Testing and Microscopical, St. Peter's Close, Sheffield.

'Phone: 287 SLOUGH

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8" Plain jolter, 51"×42" table	£90
13" Plain jolter, 76"×52" table	£140
24"×48" Portable turnover jolter	£130
18"×36" Portable turnover jolter	£90
30"×40" Turnover jolter, 20" draw	£140
40"×50" Turnover jolter, 28" draw	£340
50"×60" Turnover jolter, 30" draw	£440
"ADAPTABLE" machine, standard type	£15

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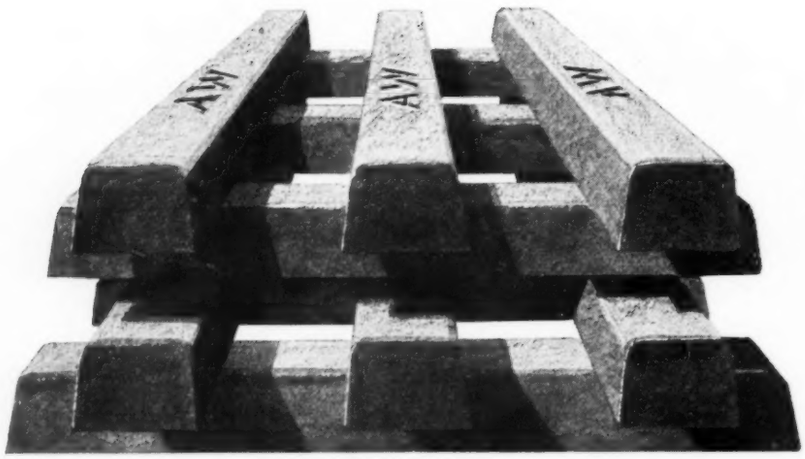

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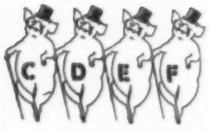

	C.	Si.	Mn.	P.	S.
GRADE C.—(Tensile—13 tons/sq. in.)	3.2	1.5–1.7	0.5–0.8	0.5–0.8	0.06
GRADE D.—(Tensile—15 tons/sq. in.)	3.2	1.2–1.35	0.8–1.0	0.4–0.7	0.07
GRADE E.—(Tensile—17 tons/sq. in.)	3.2	0.8–1.0	0.8–1.0	0.4	0.08
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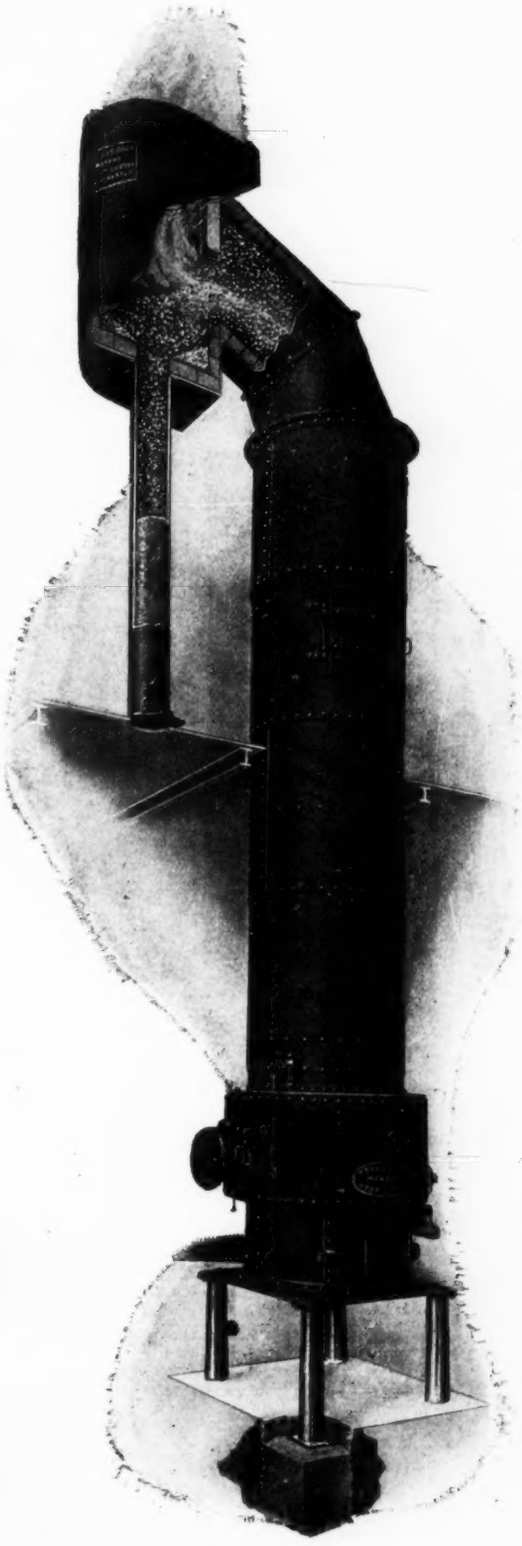

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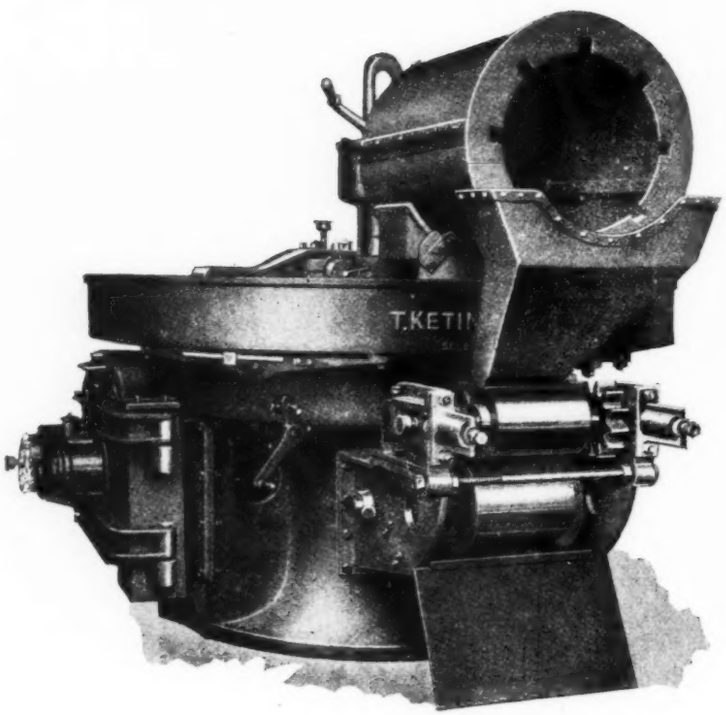

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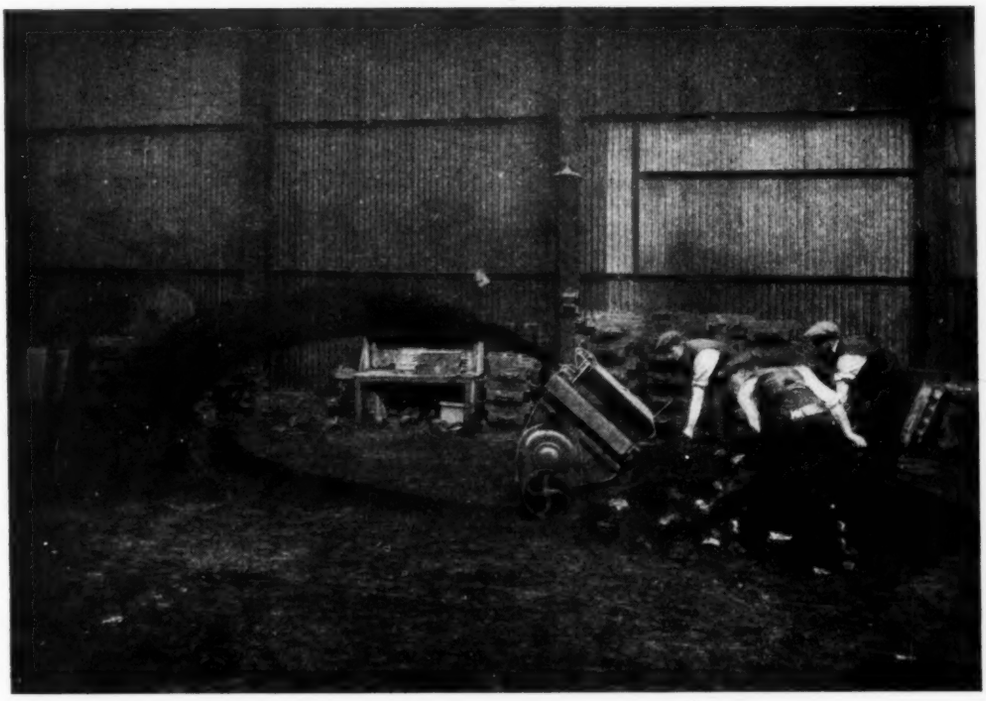

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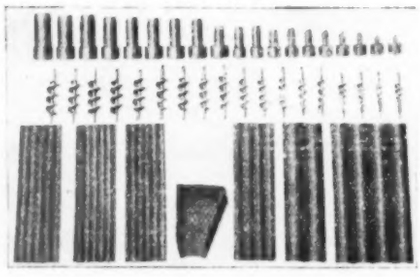

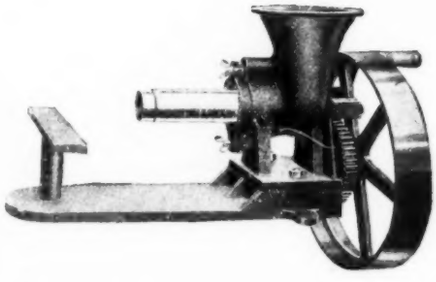

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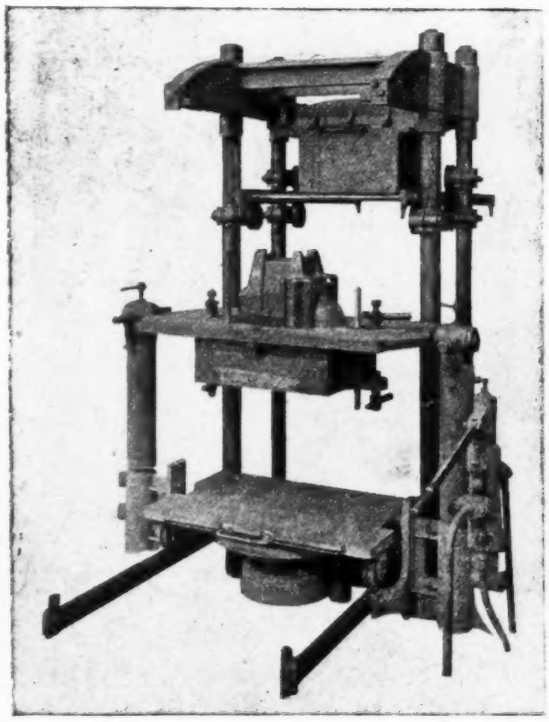

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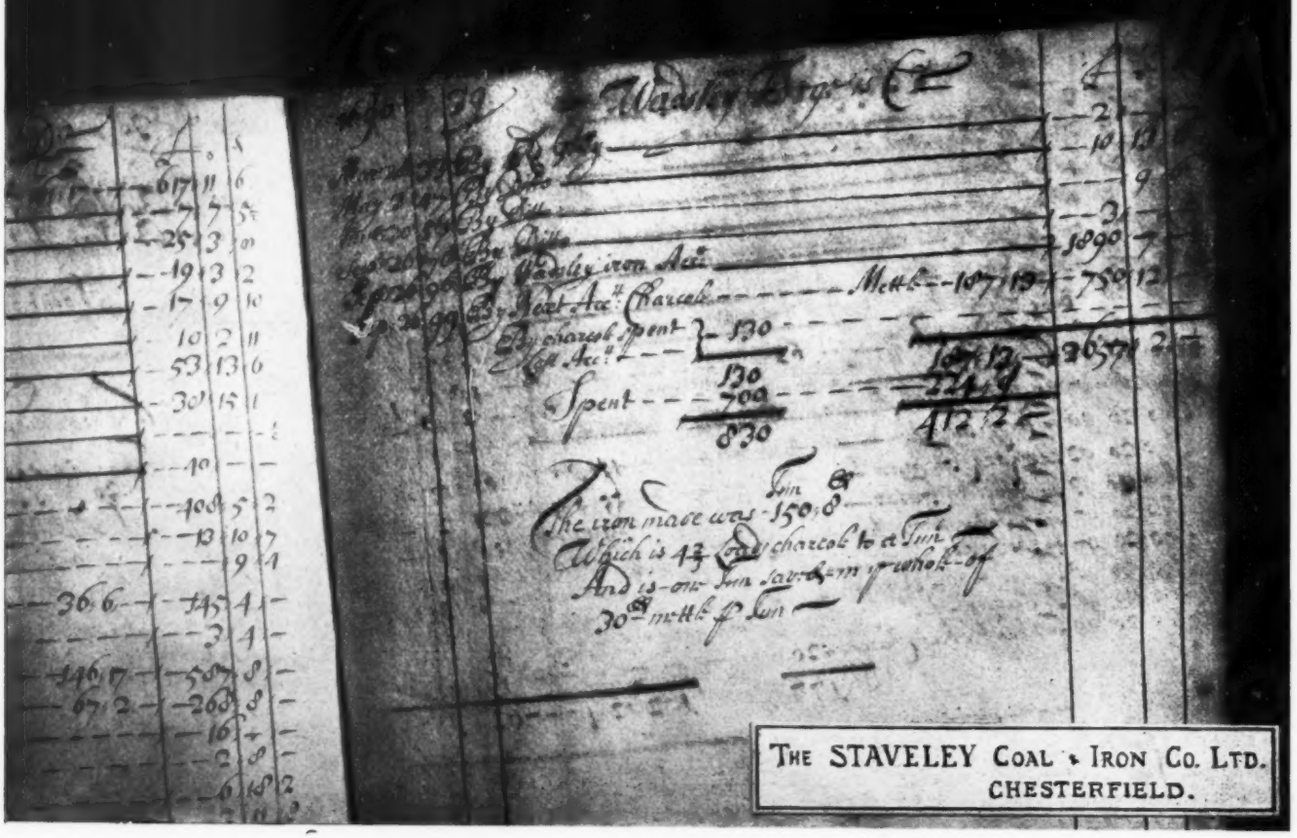

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Akrill, C., & Co., Ltd.	13
Alldays & Onions, Ltd.	4
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Armstrong, Whitworth, Sir W. G., & Co., Ltd.	23
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Badische Maschinenfabrik	—
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Bailey, Sir W. H., & Co., Ltd.	19
Baldwins, Ltd.	—
Baxter, W. H., Ltd.	28
Beasler, Waechter & Co., Ltd.	—
Blackfriars Foundry Requisite Co., Ltd., The	26
Bradley & Foster, Ltd.	22
Brealey, W., & Co., Ltd.	—
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Evans, J., & Co.	14
Findlay, A., & Co., Ltd.	—
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Fordath Engineering Co., Ltd.	8
Foster Bros.	22
Foundry & Engineering Co., The	—
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Gadd, Thos.	—
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Midland Sand Blast and Foundry Supplies Co. Ltd.	24
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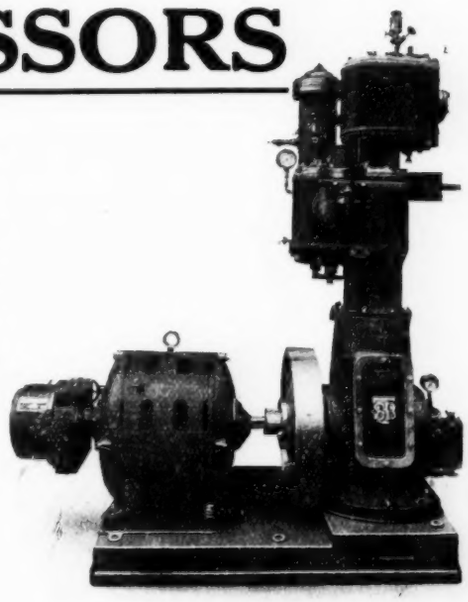

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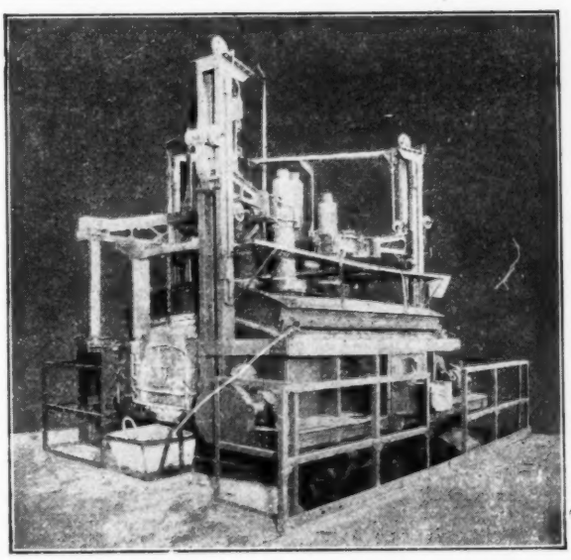

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Branch Office—
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Approximate Analyses of SHOTTS PIG IRON

FOUNDRY, FORGE AND CYLINDER QUALITIES.

	Iron. %	Graphitic Carbon. %	Combined Carbon. %	Silicon. %	Sulphur. %	Phos. %	Mang. %
No. 1	91.23	3.55	.25	3.25	.02	.50	1.20
No. 3 Soft	91.78	3.45	.30	2.80	.02	.50	1.15
No. 3 Medium	92.25	3.35	.37	2.40	.03	.50	1.10
No. 3 Hard...	92.71	3.20	.45	2.10	.04	.50	1.00
No. 4 Soft	93.19	3.15	.45	1.70	.06	.50	.95
No. 4 Hard...	93.74	2.85	.63	1.35	.08	.50	.85
Cylinder Iron	93.84	2.65	.67	1.50	.09	.40	.85
High Duty	92.95	2.90	.68	1.60	.07	.35	1.45
Low Phosphorus	92.73	3.30	.45	2.50	.03	.14	.85
Mottled	94.25	2.00	1.50	.90	.15	.50	.70
White	94.75	.60	2.80	.50	.25	.50	.60

Compositions other than the above regularly made to Customer's requirements.

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Blast Furnace Pitch, Creosote, and Sulphate of Ammonia.
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"Shotts" Brick for Building purposes.

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Lime for Building, Agricultural purposes, &c.
Slag for Ballasting and Road Making broken to sizes to suit purchasers.

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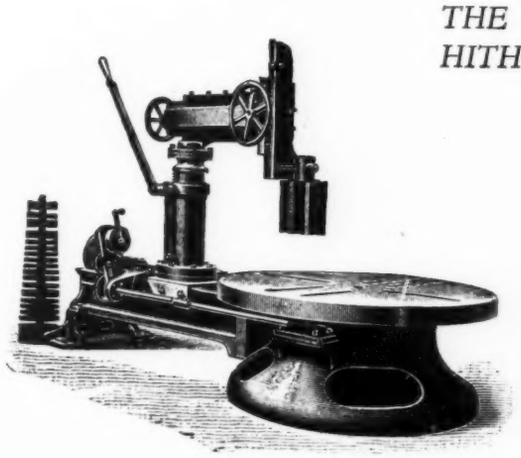

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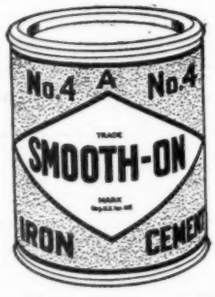

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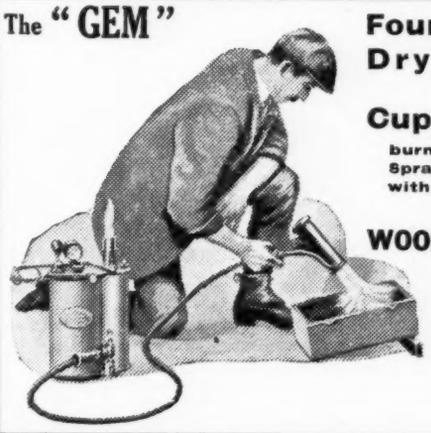
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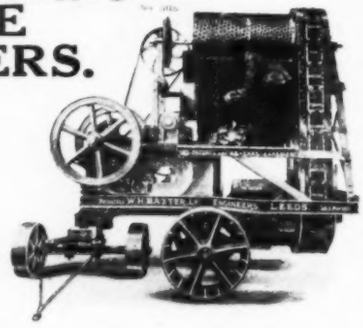

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